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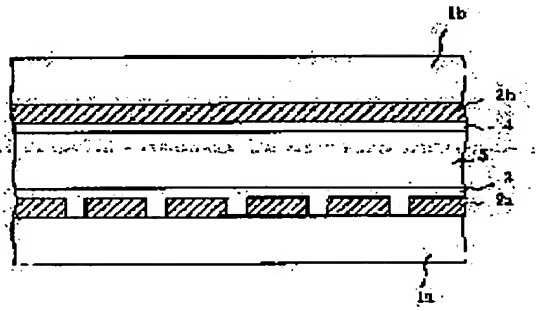
(54) ORIENTING METHOD OF LIQUID CRYSTAL, PRODUCTION OF LIQUID CRYSTAL ELEMENT, AND LIQUID CRYSTAL ELEMENT AND DISPLAY DEVICE BY THAT PRODUCTION METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To suppress irregularity in characteristics of an element and to obtain a wide driving margin by subjecting a liquid crystal to at least one cycle of temp. increasing and decreasing treatment in the temp. range of a chiral smectic phase.
SOLUTION: The liquid crystal 5 is a chiral smectic liquid crystal and shows an increase in the layer distance in a SmA phase during the temp. is decreased. Moreover, a liquid crystal showing 1% or more increase in the layer distance in the SmA phase is preferably used. Further, a liquid crystal satisfying the relation of dmin/dmax≥0.990 is preferably used, wherein dmax is the largest layer distance of the smectic liquid crystal and dmin is the smallest layer distance of the liquid crystal in the temp. range of the smectic phase. The liquid crystal 5 heated to a temp. showing an isotropic phase is injected into a cell and subjected to at least one cycle of temp. increasing and decreasing process in the SmC phase. Thereby, irregularity in orientation of the liquid crystal element as a display medium can be suppressed, the obtd. element has a wide driving margin and shows excellent driving characteristics. Thus, a display image with high precision, fast operation and a large area can be obtd.



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[Date of request for examination] 26.11.1998
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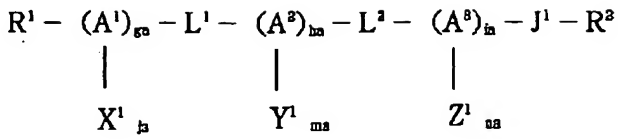
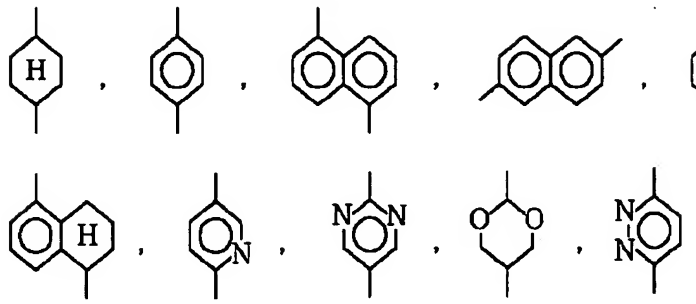
[Date of extinction of right]	11.08.2004

[Claim(s)]
[Claim 1] The orientation approach of the liquid crystal characterized by performing temperature up and at least one or more cycles of temperature fall processings to the above-mentioned liquid crystal in a chiral smectic phase temperature requirement in the liquid crystal device which comes to pinch the liquid crystal in which a chiral smectic phase is shown between the electrode substrates of a couple.
[Claim 2] The orientation approach of liquid crystal according to claim 1 that the relation between the largest smectic liquid crystal interlayer spacing dmax and the narrowest liquid crystal interlayer spacing dmin fills [the above-mentioned liquid crystal] dmin/dmax>=0.990 in a chiral smectic phase temperature requirement.
[Claim 3] The orientation approach of the liquid crystal according to claim 1 or 2 which the above-mentioned liquid crystal increases [an interlayer spacing] by 1% or more in a smectic A phase at the time of a temperature fall.
[Claim 4] claims 1-3 in which the above-mentioned liquid crystal has the structure where a book-shelf or the layer angle of inclination near it is small, in a chiral smectic phase -- the orientation approach of liquid crystal given in either.
[Claim 5] claims 1-4 in which the above-mentioned liquid crystal does not have a cholesteric phase -- the orientation approach of liquid crystal given in either.
[Claim 6] The orientation approach of the liquid crystal according to claim 5 which is the liquid crystal constituent with which said liquid crystal contains the fluorine content liquid crystal compound which it has a part for a part for a fluorocarbon end, and a hydrocarbon end, and this both-ends part is combined by the core, and has a smectic intermediate phase or a potential smectic intermediate phase.
[Claim 7] The orientation approach of liquid crystal according to claim 6 that the amount of [in said fluorine content liquid crystal compound] fluorocarbon end is the radical expressed with -D1-CxaF2 xa-X. (However, the above-mentioned inside xa of a formula is 1-20, and X expresses -H or -F. D1) - CO-O-(CH2) ra-, -O-(CH2) ra-, -(CH2) ra-, - Express O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4.
[Claim 8] The orientation approach of liquid crystal according to claim 6 that the amount of [in said fluorine content liquid crystal compound] fluorocarbon end is the radical expressed with -D2-(CxbF2 xb-O) za-CyaF2ya+1. (However, the above-mentioned inside xb of a formula is 1-10 independently of each (CxbF2 xb-O). ya) It is 1-10 and za(s) are 1-10. D2 - CO-O-CrcH2rc-, -O-CrcH2rc-, -CrcH2rc-, - O-(CsaH2 sa-O) ta-CrdH2rd-, -O-SO2-, - SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, - It is chosen out of CrcH2 rc-N(CpbH2pb+1)-CO- and single bond, rc and rd are 1-20 independently, respectively, sa(s) are 1-10 independently of each (CsaH2 sa-O), ta(s) are 1-6, and pb(s) are 0-4.
[Claim 9] The orientation approach of liquid crystal according to claim 6 that said fluorine content liquid crystal compound is expressed with the following general formula (I).
[Formula 1]

一般式 (I)



〔式中、A^1、A^2、A^3は、それぞれ独立に、

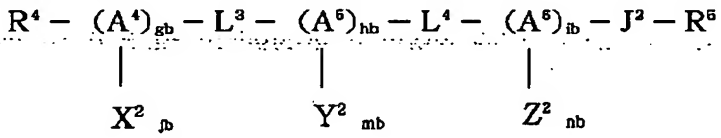


********. ga, ha, and ia express the integer (however, ga+ha+ia is at least 2) of 0-3 independently. Independently each L1 and L2 Single bond, -CO-O-, -O-CO-, - Express COS-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, -Te-CO-, -CH2CH2-, -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-. Each X1, Y1, and Z1 are the substituent of A1, A2, and A3, and -H, -Cl, -F, -Br, -I, -OH, -OCH3, -CH3, -CN, or -NO2 is expressed independently, and each ja, ma, and na express the integer of 0-4 independently. J1 -CO-O-(CH2) ra-, -O-(CH2) ra-, - Express CH2ra-, -O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4. R1 expresses -O-CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-R3, -O-CqaH2 qa-R3, -CO-O-CqaH2 qa-R3, or -O-CO-CqaH2 qa-R3. The shape of a straight chain, You may be any of the letter of branching (however, R3 expresses -O-CO-CqbH2qb+1, -CO-O-CqbH2qb+1, -H, -Cl, -F, -CF3, -NO2, and -CN, and qa and qb are 1-20 independently). R2 expresses CxaF2 xa-X (X expresses -H or -F and xa is the integer of 1-20).]

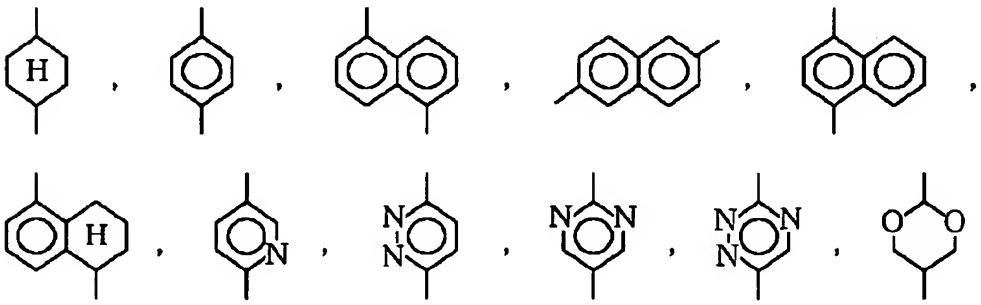
[Claim 10] The orientation approach of liquid crystal according to claim 6 that said fluorine content liquid crystal compound is expressed with the following general formula (II).

[Formula 2]

一般式 (II)



〔式中、A^4、A^5、A^6は、それぞれ独立に、



********. gb, hb, and ib express the integer (however, gb+hb+ib is at least 2) of 0-3 independently, respectively. Independently each L3 and L4 Single bond, -CO-O-, -O-CO-, - CO-S-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, - Express Te-CO-, -(CH2CH2) ka- (ka is 1-4), -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-. Each X2, Y2, and Z2 are A4, A5, and the substituent of A6, and -H, -Cl, -F,

-Br, -I, -OH, -OCH3, -CH3, -CF3, -OCF3, -CN, or -NO2 is expressed independently, and each jb, mb, and nb express the integer of 0-4 independently. J2 -CO-O-CrcH2rc-, -O-CrcH2rc-, - CrcH2rc-, -O-(CsaH2 sa-O) ta-CrdH2rd-, - O-SO2-, -SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, - It is CrcH2 rc-N(CpbH2pb+1)-CO-, rc and rd are 1-20 independently, sa(s) are 1-10 independently of each (CsaH2 sa-O), ta(s) are 1-6, and pb(s) are 0-4. R4 - Express O-(CqcH2 qc-O) wa-CqdH2qd+1, -(CqcH2 qc-O) wa-CqdH2qd+1, -CqcH2 qc-R6, -O-CqcH2 qc-R6, -CO-O-CqcH2 qc-R6, or -O-CO-CqcH2 qc-R6. You may be any of the shape of a straight chain, and the letter of branching (however, R6 expresses -O-CO-CqdH2qd+1, -CO-O-CqdH2qd+1, -Cl, -F, -CF3, -NO2, -CN, or -H, and the integer of 1-20 and wa of qc and qd are the integers of 1-10 independently). R5 is expressed with za-CyaF(CxbF2 xb-O) 2ya+1 (however, for the above-mentioned inside xb of a formula, it is 1-10 independently of each (CxbF2 xb-O), ya(s) are 1-10, and za(s) are 1-10).]

[Claim 11] claims 1-10 whose above-mentioned liquid crystal is ferroelectric liquid crystals -- the orientation approach of liquid crystal given in either.

[Claim 12] claims 1-10 whose above-mentioned liquid crystal is antiferroelectricity liquid crystal -- the orientation approach of liquid crystal given in either.

[Claim 13] The manufacture approach of the liquid crystal device which is the manufacture approach of the liquid crystal device which comes to pinch the liquid crystal in which a chiral smectic phase is shown between the electrode substrates of a couple, takes down after injecting the liquid crystal of an isotropic phase into a cel, and is characterized by performing temperature up and at least one or more cycles of temperature fall processings to the above-mentioned liquid crystal in a chiral smectic phase temperature requirement.

[Claim 14] The manufacture approach of the liquid crystal device according to claim 13 which prepared the orientation control layer in the field which touches one [at least] liquid crystal of the electrode substrate of a up Norikazu pair.

[Claim 15] The manufacture approach of the liquid crystal device according to claim 14 which prepared the orientation control layer in the field which touches each liquid crystal of the electrode substrate of a up Norikazu pair.

[Claim 16] The manufacture approach of the liquid crystal device according to claim 15 which prepared a mutually different orientation control layer in the field which touches the liquid crystal of the electrode substrate of a up Norikazu pair.

[Claim 17] The manufacture approach of the liquid crystal device according to claim 15 which prepared the same orientation control layer as the field which touches the liquid crystal of the electrode substrate of a up Norikazu pair.

[Claim 18] claims 13-17 with which the relation between the largest smectic liquid crystal interlayer spacing dmax and the narrowest liquid crystal interlayer spacing dmin fills [the above-mentioned liquid crystal] dmin/dmax>=0.990 in a chiral smectic phase temperature requirement -- the manufacture approach of a liquid crystal device given in either.

[Claim 19] claims 13-18 which the above-mentioned liquid crystal increases [an interlayer spacing] by 1% or more in a smectic A phase at the time of a temperature fall -- the manufacture approach of a liquid crystal device given in either.

[Claim 20] claims 13-19 in which the above-mentioned liquid crystal has the structure where a book-shelf or the layer angle of inclination near it is small, in a chiral smectic phase -- the manufacture approach of a liquid crystal device given in either.

[Claim 21] claims 13-20 in which the above-mentioned liquid crystal does not have a cholesteric phase -- the manufacture approach of a liquid crystal device given in either.

[Claim 22] The manufacture approach of the liquid crystal device according to claim 21 which is the liquid crystal constituent with which said liquid crystal contains the fluorine content liquid crystal compound which it has a part for a part for a fluorocarbon end, and a hydrocarbon end, and this both-ends part is combined by the core, and has a smectic intermediate phase or a potential smectic intermediate phase.

[Claim 23] The manufacture approach of a liquid crystal device according to claim 22 that the amount of [in said fluorine content liquid crystal compound] fluorocarbon end is the radical expressed with -D1-CxaF2 xa-X. (However, the above-mentioned inside xa of a formula is 1-20, and X expresses -H or -F. D1) - CO-O-(CH2) ra-, -O-(CH2) ra-, -(CH2) ra-, - Express O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4.

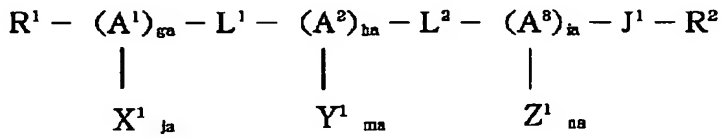
[Claim 24] The manufacture approach of a liquid crystal device according to claim 22 that the amount of [in said fluorine content liquid crystal compound] fluorocarbon end is the radical expressed with -D2-(CxbF2 xb-O) za-CyaF2ya+1. (However, the above-mentioned inside xb of a formula is 1-10

independently of each (CxbF2 xb-O). ya) It is 1-10 and za(s) are 1-10. D2 - CO-O-CrcH2rc-, -O-CrcH2rc-, -CrcH2rc-, - O-(CsaH2 sa-O) ta-CrdH2rd-, -O-SO2-, - SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, - It is chosen out of CrcH2 rc-N(CpbH2pb+1)-CO- and single bond, rc and rd are 1-20 independently, respectively, sa(s) are 1-10 independently of each (CsaH2 sa-O), ta(s) are 1-6, and pb(s) are 0-4.

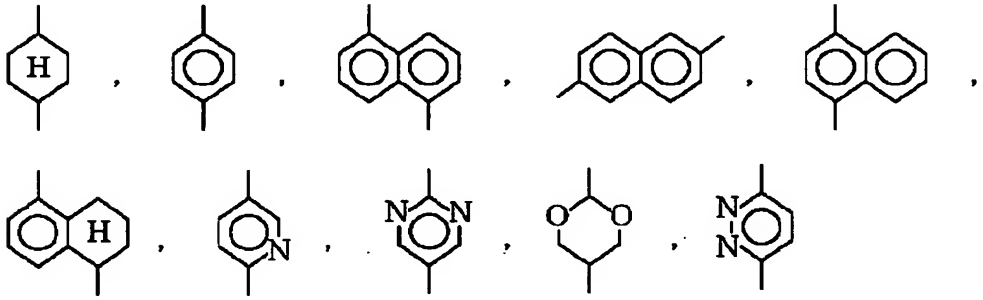
[Claim 25] The manufacture approach of a liquid crystal device according to claim 22 that said fluorine content liquid crystal compound is expressed with the following general formula (I).

[Formula 3]

一般式 (I)



〔式中、A^1、A^2、A^3は、それぞれ独立に、

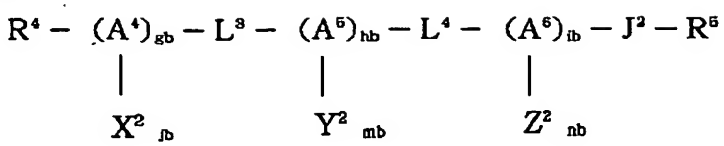


********. ga, ha, and ia express the integer (however, ga+ha+ia is at least 2) of 0-3 independently. Independently each L1 and L2 Single bond, -CO-O-, -O-CO-, - Express COS-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, -Te-CO-, -CH2CH2-, -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-. Each X1, Y1, and Z1 are the substituent of A1, A2, and A3, and -H, -Cl, -F, -Br, -I, -OH, -OCH3, -CH3, -CN, or -NO2 is expressed independently, and each ja, ma, and na express the integer of 0-4 independently. J1 -CO-O-(CH2) ra-, -O-(CH2) ra-, - Express CH2ra-, -O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4. R1 expresses -O-CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-R3, -O-CqaH2 qa-R3, -CO-O-CqaH2 qa-R3, or -O-CO-CqaH2 qa-R3. The shape of a straight chain, You may be any of the letter of branching (however, R3 expresses -O-CO-CqbH2qb+1, -CO-O-CqbH2qb+1, -H, -Cl, -F, -CF3, -NO2, and -CN, and qa and qb are 1-20 independently). R2 expresses CxaF2 xa-X (X expresses -H or -F and xa is the integer of 1-20).]

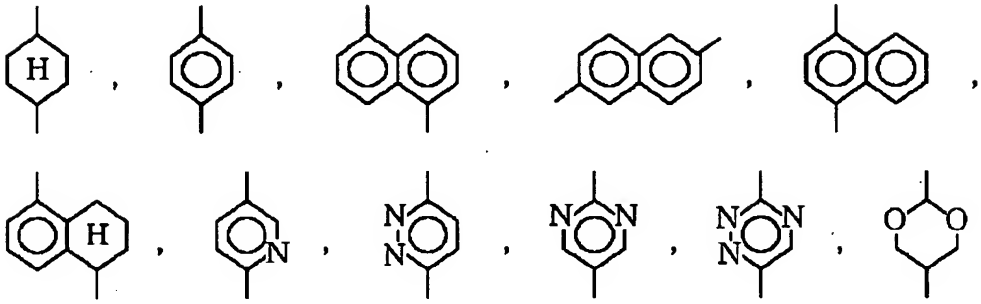
[Claim 26] The manufacture approach of a liquid crystal device according to claim 22 that said fluorine content liquid crystal compound is expressed with the following general formula (II).

[Formula 4]

一般式 (II)



〔式中、A⁴、A⁵、A⁶は、それぞれ独立に、



********. gb, hb, and ib express the integer (however, gb+hb+ib is at least 2) of 0-3 independently, respectively. Independently each L3 and L4 Single bond, -CO-O-, -O-CO-, - CO-S-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, - Express Te-CO-, -(CH2CH2) ka- (ka is 1-4), -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-. Each X2, Y2, and Z2 are A4, A5, and the substituent of A6, and -H, -Cl, -F, -Br, -I, -OH, -OCH3, -CH3, -CF3, -OCF3, -CN, or -NO2 is expressed independently, and each jb, mb, and nb express the integer of 0-4 independently. J2 -CO-O-CrcH2rc-, -O-CrcH2rc-, - CrcH2rc-, -O-(CsaH2 sa-O) ta-CrdH2rd-, - O-SO2-, -SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, - It is CrcH2 rc-N(CpbH2pb+1)-CO-, rc and rd are 1-20 independently, sa(s) are 1-10 independently of each (CsaH2 sa-O), ta(s) are 1-6, and pb(s) are 0-4. R4 - Express O-(CqcH2 qc-O) wa-CqdH2qd+1, -(CqcH2 qc-O) wa-CqdH2qd+1, -CqcH2 qc-R6, -O-CqcH2 qc-R6, -CO-O-CqcH2 qc-R6, or -O-CO-CqcH2 qc-R6. You may be any of the shape of a straight chain, and the letter of branching (however, R6 expresses -O-CO-CqdH2qd+1, -CO-O-CqdH2qd+1, -Cl, -F, -CF3, -NO2, -CN, or -H, and the integer of 1-20 and wa of qc and qd are the integers of 1-10 independently). R5 is expressed with za-CyaF(CxbF2 xb-O) 2ya+1 (however, for the above-mentioned inside xb of a formula, it is 1-10 independently of each (CxbF2 xb-O), ya(s) are 1-10, and za(s) are 1-10).]

[Claim 27] claims 13-26 whose above-mentioned liquid crystal is ferroelectric liquid crystals -- the manufacture approach of a liquid crystal device given in either.

[Claim 28] claims 13-26 whose above-mentioned liquid crystal is antiferroelectricity liquid crystal -- being absent -- the manufacture approach of a liquid crystal device given in **.

[Claim 29] claims 13-28 -- the liquid crystal device characterized by being manufactured by either by the manufacture approach of a publication.

[Claim 30] The display characterized by having a liquid crystal device according to claim 29 and the driving means of this liquid crystal device.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the orientation approach of the liquid crystal in this liquid crystal device further about the display using the liquid crystal device and this liquid crystal device which are used for the light valve used for a flat-panel display, a projection display, a printer, etc., and its manufacture approach.

[0002]

[Description of the Prior Art] as the liquid crystal device used extensively conventionally -- for example, em shut (M. Schadt), the W. Helfrich (W. Helfrich) work, and applied physics Letters (Applied Physics Letters) -- the thing using the 18th volume and the Twisted Nematic (Twisted Nematic) liquid crystal shown in the 127-128th page of the 4 No. (February 15, 1971 issuance) is known.

[0003] Moreover, a passive-matrix type liquid crystal device is one of those which are known as a configuration of a typical liquid crystal device. Component production is easy for this type, and it is predominant in respect of cost. However, since there was a trouble that a cross talk occurs, at the time of the time-sharing actuation using the matrix electrode structure which made the pixel consistency high,

the number of pixels was restricted. Moreover, since the speed of response was as slow as ten or more mses, the application as a display was restricted.

[0004] In recent years, development of the liquid crystal device called TFT (thin film transistor) type is performed to the component above passive-matrix type. In order that this type may attach a transistor to each pixel, it becomes difficult to produce a liquid crystal device that there is no defect pixel as it becomes a large area, while the problem of a cross talk or a speed of response is solved, and great cost is generated even if producible.

[0005] As what improves the trouble of the liquid crystal device of such a conventional type, the component using the liquid crystal in which bistability nature is shown is proposed by Clerks (Clark) and RAGAWORU (Lagerwall) (JP,56-107216,A, U.S. Pat. No. 4367924 description). The ferroelectric liquid crystal which has the chiral smectic C (SmC*) phase which is generally one of the chiral smectic liquid crystal as liquid crystal in which this bistability nature is shown is used. Since this ferroelectric liquid crystal performs reversal switching by spontaneous polarization, it can make the bistability condition which a rapid-response rate is dramatically obtained upwards and has memory nature discover. Since the angle-of-visibility property is furthermore also excellent, it is thought that it is suitable as the display device or light valve of a high speed, a high definition, and a large area.

[0006] On the other hand, there was a problem of a zigzag-like orientation defect having occurred and reducing contrast remarkably as the liquid crystal device using chiral smectic liquid crystal was indicated by the structure and the physical properties (Corona Publishing, Atsuo Fukuda, the Hideo Takezoe work, 1990) of "ferroelectric liquid crystal, for example. The layer structure of the ferroelectric liquid crystal supported between vertical substrates forms two kinds of Chevron structures, and this defect originates in the bending include angle (the tilt angle delta of a layer) of that layer system being quite large. the Chevron structure which has such a problem recently is canceled, and the layer structure called book-shelf or the structure near it is appeared -- making -- high -- there is a motion that a good contrast liquid crystal device will be realized. For example, the liquid crystallinity compounds (a U.S. Pat. No. 5262082 official report, the international application patent WO 93/No. 22396, the international congress on the a little more than 1993 4th [per year] dielectric liquid crystal, P-46, Mark Di Radcliffe (Marc D.Radcliffe), etc.) which have a perfluoro ether side chain as a liquid crystal ingredient which appears a book-shelf or the structure near it are indicated. This liquid crystal can appear the structure where the layer angle of inclination near a book-shelf is small also for ** not using external fields, such as electric field.

[0007] As a reason a liquid crystal compound with an above-mentioned perfluoro ether side chain presents book-shelf structure, it is thought that it is because it has the property that liquid crystal molecule spacing increases as it is on a low temperature side. That is, generally, in a chiral smectic liquid crystal device, in case orientation of the liquid crystal molecule is carried out through a cooling process from a hot liquid condition (isotropic phase condition), a layer system is formed in a smectic A (SmA) phase, and it is SmC*. A liquid crystal molecule inclines from a layer normal by carrying out phase transition to a phase for a chiral smectic CA phase (SmCA)]. Only the part to which the liquid crystal molecule inclined from the layer normal at this time cannot but take the Chevron structure, in order that it may compensate a volumetric shrinkage, since an interlayer spacing becomes short. On the other hand, the liquid crystal compound with a perfluoro ether side chain Since it has the property that liquid crystal molecule spacing increases as it is on a low temperature side, SmC* Even if a liquid crystal molecule inclines from a layer normal by carrying out phase transition to a phase (or SmCA phase) Molecule spacing is offset by the property said that a low temperature side becomes long, and it is SmC*. The interlayer spacing in a phase (or SmCA phase) can take the value near the interlayer spacing in a SmA phase. Therefore, ** can also make the structure where a book-shelf or the layer angle of inclination near it is small appear spontaneously not using external fields, such as electric field.

[0008]

[Problem(s) to be Solved by the Invention] However, with the liquid crystal ingredient with which the above molecule spacing becomes long by the low temperature side when this invention person etc. observes, it is SmC*. In the phase (or SmCA phase), it turned out that the field where the component properties of the molecule by an apparent tilt angle and an apparent information signal electrical potential difference, such as fluctuation, differ presents the orientation condition of be distribute disorderly. a field with few [here / for convenience / relatively / an apparent tilt angle is large and] amounts of fluctuation of the molecule by the information signal electrical potential difference -- P -- an apparent tilt angle calls P2 field relatively a field with many [small] amounts of fluctuation of the molecule by the information signal electrical potential difference 1 field.

[0009] As a result of repeating a detailed examination as a reason which the field where the above

properties differ appears, it is thought that the following is the cause.
[0010] That is, molecule spacing is usually SmC* with the liquid crystal ingredient with which a low temperature side becomes long. Also not only in a phase (or SmCA phase) but in the SmA phase, molecule spacing has the property that a low temperature side becomes long. That is, the structure where a book-shelf or the layer angle of inclination near it is small is formed by carrying out phase transition to a SmA phase from the phase by the side of an elevated temperature (an isotropic phase, a nematic phase, or cholesteric phase). Then, if it cools further, the force which is going to lengthen molecule spacing will work, but since it is fixed, the layer normal lay length of a liquid crystal device, i.e., (layer pitch), x, (number of layers) serves as the form where the whole system receives compressive force only as for the part to which molecule spacing is extended by cooling.
[0011] On the other hand, although this compression should start homogeneity to all layers essentially, the compression unevenness of the part strongly compressed by unevenness, such as a cel and temperature, and the part which is not compressed so strongly will be produced. That is, the layer compression unevenness in a SmA phase is SmC*. It will become the unevenness of the component property in a phase (or SmCA phase), and will appear.
[0012] When P1 and P2 field where the above component properties differ is changing continuously, it does not become especially a problem practically, but when two fields are changing nonsequetially (rapidly), the boundary part of these fields will become a defect, will become lowering of contrast, and the cause of abnormality reversal domain generating, and will cause actuation margin lowering.
[0013] The object of this invention is SmC* which originates in the layer compression unevenness at the time of the elevated temperature in a SmA phase in the liquid crystal device which used chiral smectic liquid crystal. Generating of the unevenness of the component property in a phase (or SmCA phase) is controlled, a large actuation margin is realized, and it is in offering a good display.
[0014]
[Means for Solving the Problem] It is the orientation approach of the liquid crystal characterized by performing temperature up and at least one or more cycles of temperature fall processings to the above-mentioned liquid crystal in a chiral smectic phase temperature requirement the first of this invention in the liquid crystal device which comes to pinch the liquid crystal in which a chiral smectic phase is shown between the electrode substrates of a couple.
[0015] Moreover, the second of this invention is the manufacture approach of the liquid crystal device which comes to pinch the liquid crystal in which a chiral smectic phase is shown between the electrode substrates of a couple, and is the manufacture approach of the liquid crystal device which takes down after injecting the liquid crystal of an isotropic phase into a cel, and is characterized by performing temperature up and at least one or more cycles of temperature fall processings to the above-mentioned liquid crystal in a chiral smectic phase temperature requirement.
[0016] It is the liquid crystal device furthermore characterized by manufacturing the third of this invention by the above-mentioned manufacture approach, and the fourth is a display characterized by having this liquid crystal device and its driving means.
[0017] This invention has the description by canceling or easing the orientation unevenness resulting from the layer compression unevenness in a SmA phase peculiar to the liquid crystal ingredient in which the structure where a book-shelf or the layer angle of inclination near it is small is shown spontaneously to have raised the actuation margin. That is, in this invention, it is equalizing by carrying out re-temperature up of the layer compression unevenness produced by the increment in the interlayer spacing by cooling of liquid crystal in a chiral smectic phase. In the liquid crystal device by which compression unevenness was eased, the unevenness of a component property is controlled and a large actuation margin is obtained.
[0018]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail in accordance with 1 operation gestalt of the liquid crystal device of this invention shown in drawing 1 . In addition, drawing 1 is a cross section and, for 1a and 1b, a substrate, 2a, and 2b of an electrode, and 3 and 4 are [an orientation control layer and 5] liquid crystal among drawing.
[0019] In the liquid crystal device of this invention, the substrates 1a and 1b of a couple which consist of glass, plastics, etc. counter, and are arranged, and electrode 2a of a predetermined pattern configuration and 2b are formed on each substrate, respectively. These electrodes are In2 O and SnO2. Or transparence electric conduction film, such as ITO (Indium Tin Oxide), is used. Moreover, in this operation gestalt, electrode 2a and 2b are formed in the shape of a stripe, respectively, they are arranged so that it may intersect perpendicularly substantially mutually, and they constitute the matrix electrode. In this invention, one electrode 2 can be formed with a metal etc. and it can also consider as the liquid crystal

device of a reflective mold. Furthermore, in this invention, electrode structure is not restricted to the above-mentioned passive-matrix structure.

[0020] On electrode 2a and 2b, the orientation control layers 3 and 4 are formed if needed, respectively. The orientation control layers 3 and 4 may be only either, and may be the combination of the same film or different film. This operation gestalt describes the desirable gestalt at the time of forming the orientation control layers 3 and 4 suitable when liquid crystal without the cholesteric phase mentioned later is used by mutually different film.

[0021] The orientation control layer 3 is a layer which is in the range whose volume-resistivity value is 1.0x104 to 1.0x1010-ohmcm preferably. As this layer, the film which consists of the film, the polycrystal, or the amorphous semiconductor which consists of polycrystal or an amorphous substance metallic oxide if needed, and the film which distributed the particle (conductive particle) in the binder are used, for example. The conductive control impurity may be added by the film which consists of the above-mentioned polycrystal or an amorphous substance metallic oxide, polycrystal, or an amorphous semiconductor, and the particle if needed, and conductivity is adjusted.

[0022] as the film which consists of said polycrystal or an amorphous substance metallic oxide -- for example, ZnO, CdO, and ZnCdOx etc. -- the film which consists of an oxide of an IIB group element, GeO2, SnO2, GeSnOx, TiO2, ZrO2, and TiZrOx etc. -- the film which consists of an oxide of an IVA group element and an IVB group element is mentioned.

[0023] As film which consists of said polycrystal or amorphous semiconductor, the film of IVB group semi-conductors, such as Si and SiC, is mentioned.

[0024] Moreover, as a particle, the particle of the oxide the above-mentioned IIB group element's, the oxide an IVA group element's, the oxide an IVB group element's, and an IVB group's semi-conductor is used, for example.

[0025] As a conductive control impurity added by the above-mentioned polycrystal or an amorphous substance metallic oxide, polycrystal or an amorphous semiconductor, and the particle, the following are mentioned if needed. Cu, Ag, Au, Li, etc. whose B, aluminum, Ga(s), In(s), etc. which are an IIIB group element as for example, an n mold impurity (impurity which raises a donor / electronic electric conduction) are IA group and IB group element as a p mold impurity (impurity which raises an acceptor/Hall conductivity) are used for the conductive control impurity doped to the oxide of an IIB group element. Moreover, B, aluminum, Ga, In, etc. whose P, As, Sb, and Bi which are VB group element as for example, an n mold impurity are an IIIB group element as a p mold impurity are used for the oxide of an IVB group element, and the conductive control impurity doped to a semi-conductor, respectively.

[0026] About such a conductive control impurity, when the surface potential by the side of the substrate which has an orientation control layer containing the ingredient with which the impurity concerned was added is forward, a donor is used, and in a negative case, an acceptor is used. The free electron of the ingredient in the condition that the impurity was added although set up about the addition concentration of an impurity according to the class of ingredient (the ingredient of a particle and an impurity should put together) and the crystallized state (amount of a crystal defect consistency), or the concentration of a free electron hole is 1.0x1011 - 1.0x1014 atm/cm3. It is desirable to make it become extent. When you use polycrystal or an amorphous ingredient as an ingredient of the parent which adds an impurity, let 1.0x1017 - 1.0x1020 atm/cm3 (it is about 0.01 - 1% to a parent ingredient) be actual additions in consideration of the addition effectiveness of an impurity.

[0027] As an ingredient used as the binder which distributes said particle, SiOx, TiOx, ZrOx, other oxide melting base materials, SHIROKISAMPORIMA, etc. are used, for example.

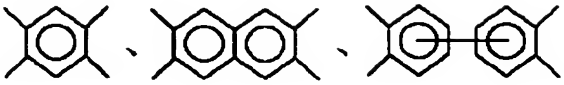
[0028] As for the orientation control layer 4, uniaxial orientation processing is made. Thickness makes 50A especially 100A or less 70A or less preferably.

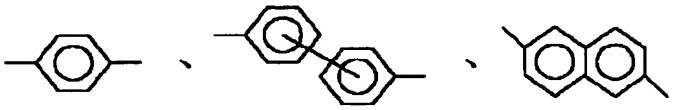
[0029] The orientation control layer 4 can be obtained by carrying out rubbing (rubbing processing) of the film front face with fibrous ingredients, such as velvet, cloth, and paper, after forming the film of the organic substance by solution spreading etc. As an ingredient used for this orientation control layer, organic materials, such as polyvinyl alcohol, polyimide, polyimidoamide, polyester, a polyamide, polyester imide, poly paraxylene, a polycarbonate, a polyvinyl acetal, polyvinyl chloride, polystyrene, a polysiloxane, cellulosic resin, melamine resin, urea resin, and acrylic resin, are mentioned. Moreover, an oxide or nitrides, such as SiO, can be vapor-deposited from across to a substrate, membranes can be formed, and it can also form with the method vacuum deposition of slanting which gives uniaxial orientation restraining force.

[0030] Especially the thing for which the polyimide film which has the repeat unit expressed with the following general formula P as an orientation control layer to which up Norikazu shaft orientation processing is performed is used is desirable.

[0031]
[Formula 5]
〔一般式P〕

$(-K-P^{11}-L^{11}-M^{11}-(L^{12})_a-P^{12}-)$

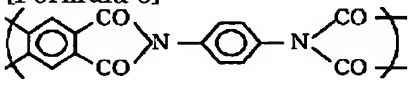
(Kは4価であり  を表し、L^{11}、L^{12}はそれぞれ独立に

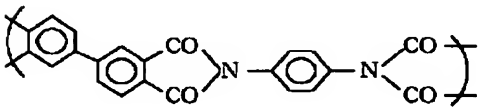


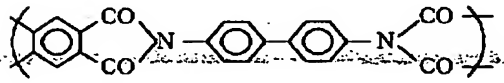
または炭素数1から20のアルキレン基を表し、P^{11}、P^{12}はイミド結合を表す。

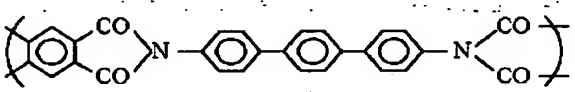
M^1は単結合または－O－を表し、aは0、1、2を表す。)

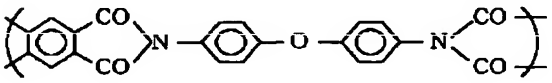
[0032] Moreover, the following repeat unit structures are mentioned as concrete structure of these polyimide.
[0033]
[Formula 6]

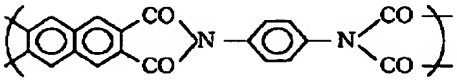


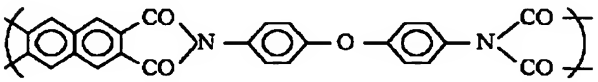


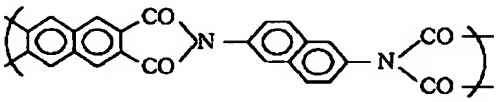




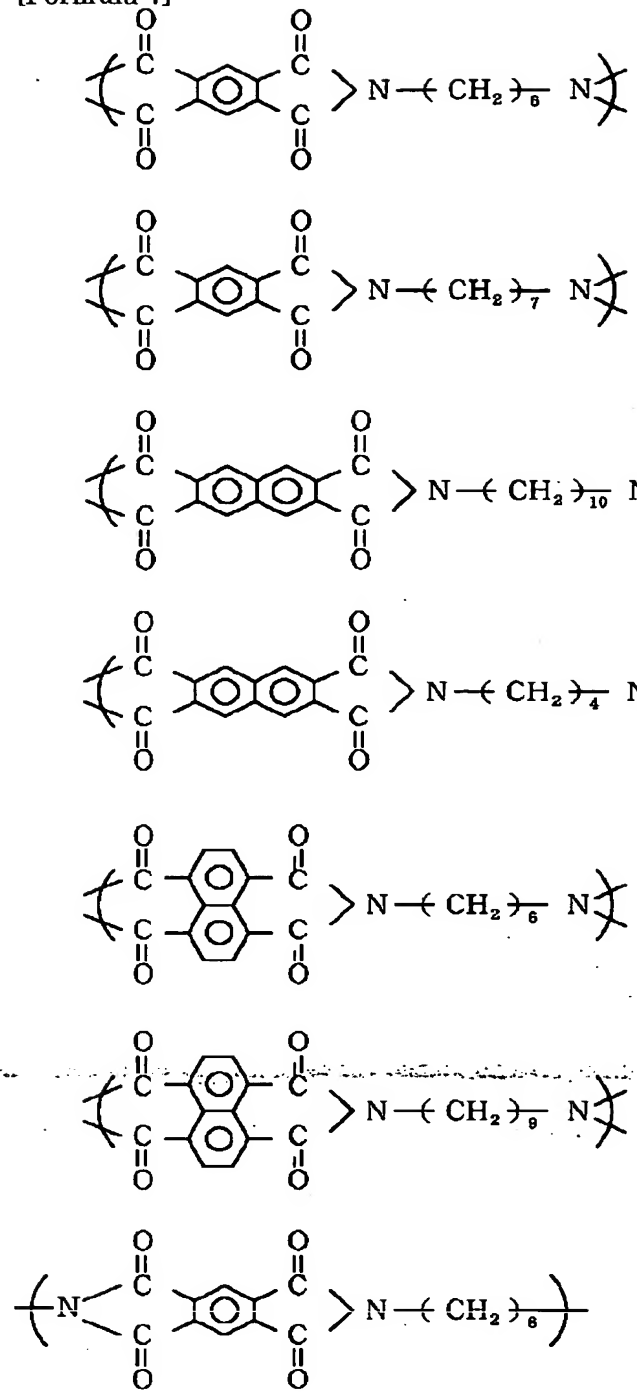








[0034]
[Formula 7]



[0035] In the liquid crystal device of this operation gestalt, it counters through a spacer bead (un-illustrating) in the field which Substrates 1a and 1b were stuck through the sealant (un-illustrating) in the periphery section, and was specified by this sealant, and the cel gap is formed. A cel gap is set as the range of about about 1-5 micrometers, when using a ferroelectric liquid crystal. Moreover, in addition to a spacer, an adhesive bead may be distributed between substrates in order to raise the adhesive property between substrates.

[0036] The liquid crystal 5 used in this invention is chiral smectic liquid crystal, and the liquid crystal which an interlayer spacing increases in a SmA phase at the time of a temperature fall is used. Therefore, the effectiveness of this invention can be acquired also in the antiferroelectricity liquid crystal which has not only a ferroelectric liquid crystal but the same property. Especially, this invention is preferably applied to the liquid crystal which an interlayer spacing increases by 1% or more in a SmA phase.

[0037] Moreover, in this invention, the liquid crystal with which the relation between the largest smectic

liquid crystal interlayer spacing dmax and the narrowest liquid crystal interlayer spacing dmin fills dmin/dmax>=0.990 is preferably used in a chiral smectic phase temperature requirement.

[0038] Liquid crystal without a cholesteric phase is mentioned as liquid crystal especially used in this invention. Moreover, when liquid crystal without a cholesteric phase is used, while BATONE occurs gradually in isotropic phase-smectic phase transition, an orientation condition is formed, but if the cel is constituted from combination of different orientation control film which was described above, BATONE will begin to occur from one substrate, the condition of saying that it grows up to be the substrate side of another side will be appeared, and it will be easy to realize good homogeneity orientation.

[0039] The liquid crystal constituent containing the fluorine content liquid crystal compound which it has a part for a part for a fluorocarbon end and a hydrocarbon end preferably as liquid crystal furthermore used in this invention, and this both-ends part is combined by the core, and has a smectic intermediate phase or a potential smectic intermediate phase is desirable.

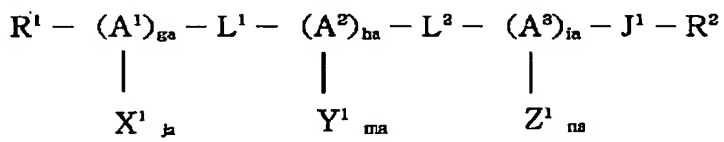
[0040] As said fluorine content liquid crystal compound, the amount of fluorocarbon end · The radical expressed with D1-CxaF2 xa-X (however, the above-mentioned inside xa of a formula is 1-20, and X expresses -H or -F D1), · CO-O-(CH2) ra-, -O-(CH2) ra-, -(CH2) ra-, · Express O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4. Or · The radical expressed with D2-(CxbF2 xb-O) za-CyaF2ya+1 (however, the above-mentioned inside xb of a formula is 1-10 independently of each (CxbF2 xb-O) ya), It is 1-10 and za(s) are 1-10. D2 · CO-O-CrcH2rc and -O-CrcH2rc-, -CrcH2rc-, · O-(CsaH2 sa-O) ta-CrdH2rd-, -O-SO2-, · SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, · it chooses out of CrcH2 rc-N(CpbH2pb+1)-CO- and single bond -- having -- rc and rd -- respectively -- independent -- 1-20 -- it is -- sa -- each (CsaH2 sa-O) -- it is 1-10 independently, ta(s) are 1-6, and pb(s) are 0-4. It can come out and a compound which exists can be used.

[0041] The following general formula (I) or the fluorine content liquid crystal compound expressed with (II) can be used especially preferably.

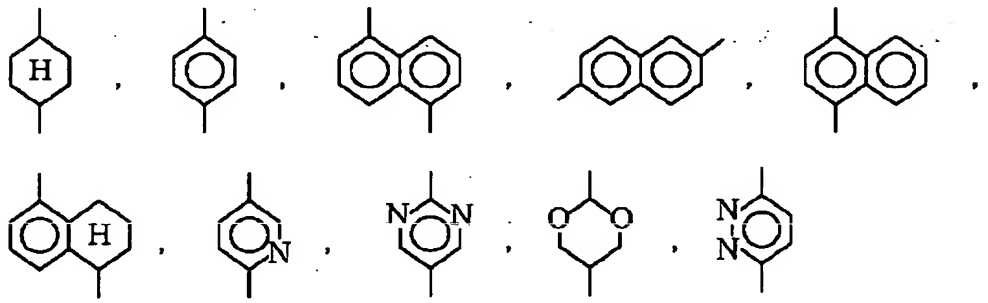
[0042]

[Formula 8]

一般式 (I)



式中、A^1、A^2、A^3は、それぞれ独立に、



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[0043] ga, ha, and ia express the integer (however, ga+ha+ia is at least 2) of 0-3 independently.

[0044] Independently each L1 and L2 Single bond, -CO-O-, -O-CO-, · Express COS-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, -Te-CO-, -CH2CH2-, -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-.

[0045] Each X1, Y1, and Z1 are the substituent of A1, A2, and A3, and -H, -Cl, -F, -Br, -I, -OH, -OCH3, -CH3, -CN, or -NO2 is expressed independently, and each ja, ma, and na express the integer of 0-4 independently.

[0046] J1 -CO-O-(CH2) ra-, -O-(CH2) ra-, · Express CH2ra-, -O-SO2-, -SO2-, -SO2-(CH2) ra-, -O-(CH2) ra-O-(CH2) rb-, -(CH2) ra-N(CpaH2pa+1)-SO2-, or -(CH2) ra-N(CpaH2pa+1)-CO-. ra and rb are 1-20 independently, and pa(s) are 0-4.

[0047] R1 expresses -O-CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-O-CqbH2qb+1, -CqaH2 qa-R3, -O-CqaH2

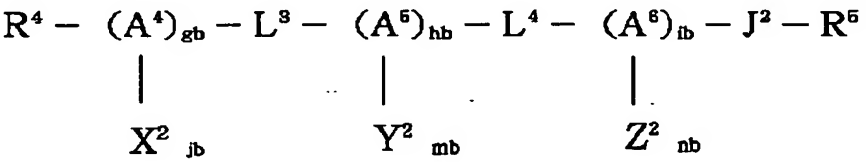
qa-R3, -CO-O-CqaH2 qa-R3, or -O-CO-CqaH2 qa-R3. The shape of a straight chain, You may be any of the letter of branching (however, R3 expresses -O-CO-CqbH2qb+1, -CO-O-CqbH2qb+1, -H, -Cl, -F, -CF3, -NO2, and -CN, and qa and qb are 1-20 independently).

[0048] R2 expresses CxaF2 xa-X (X expresses -H or -F and xa is the integer of 1-20).

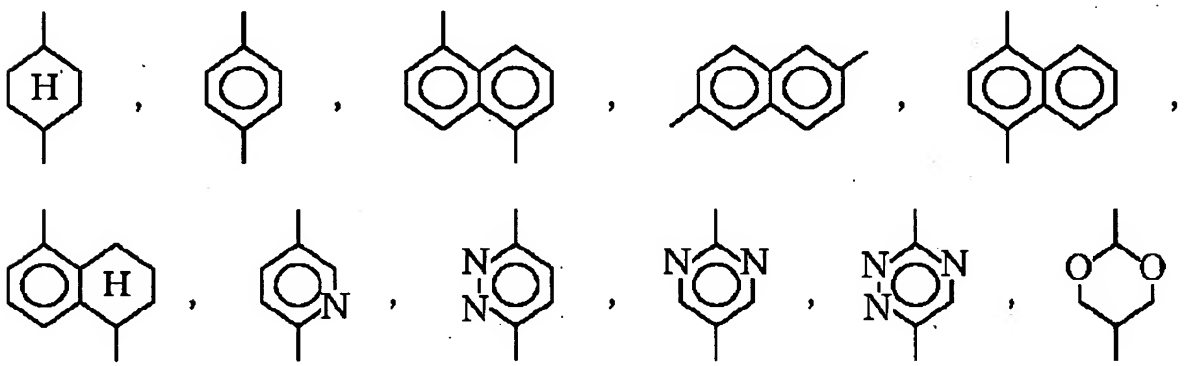
[0049]

[Formula 9]

一般式 (II)



式中、A^4、A^5、A^6は、それぞれ独立に、



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[0050] gb, hb, and ib express the integer (however, gb+hb+ib is at least 2) of 0-3 independently, respectively.

[0051] Independently each L3 and L4 Single bond, -CO-O-, -O-CO-, - CO-S-, -S-CO-, -CO-Se-, -Se-CO-, -CO-Te-, - Express Te-CO-, -(CH2CH2) ka- (ka is 1-4), -CH=CH-, -C**C-, -CH=N-, -N=CH-, -CH2-O-, -O-CH2-, -CO-, or -O-.

[0052] Each X2, Y2, and Z2 are A4, A5, and the substituent of A6, and -H, -Cl, -F, -Br, -I, -OH, -OCH3, -CH3, -CF3, -O-CF3, -CN, or -NO2 is expressed independently, and each jb, mb, and nb express the integer of 0-4 independently.

[0053] J2 -CO-O-CrcH2rc-, -O-CrcH2rc-, - CrcH2rc-, -O-(CsaH2 sa-O) ta-CrdH2rd-, - O-SO2-, -SO2-, -SO2-CrcH2rc-, -CrcH2 rc-N(CpbH2pb+1)-SO2-, - It is CrcH2 rc-N(CpbH2pb+1)-CO-, rc and rd are 1-20 independently, sa(s) are 1-10 independently of each (CsaH2 sa-O), ta(s) are 1-6, and pb(s) are 0-4.

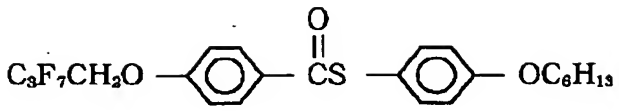
[0054] R4 - Express O-(CqcH2 qc-O) wa-CqdH2qd+1, -(CqcH2 qc-O) wa-CqdH2qd+1, -CqcH2 qc-R6, -O-CqcH2 qc-R6, -CO-O-CqcH2 qc-R6, or -O-CO-CqcH2 qc-R6. You may be any of the shape of a straight chain, and the letter of branching (however, R6 expresses -O-CO-CqdH2qd+1, -CO-O-CqdH2qd+1, -Cl, -F, -CF3, -NO2, -CN, or -H, and the integer of 1-20 and wa of qc and qd are the integers of 1-10 independently).

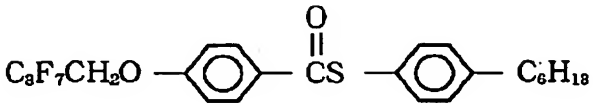
[0055] R5 is expressed with za-CyaF(CxbF2 xb-O) 2ya+1 (however, for the above-mentioned inside xb of a formula, it is 1-10 independently of each (CxbF2 xb-O), ya(s) are 1-10, and za(s) are 1-10).

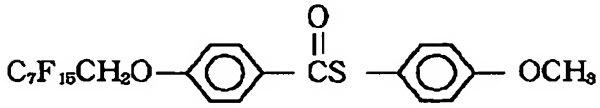
[0056] The compound expressed with the above-mentioned general formula (I) can be obtained by the approach of a publication to JP,2-142753,A and U.S. Pat. No. 5,082,587. The examples of this compound are enumerated below.

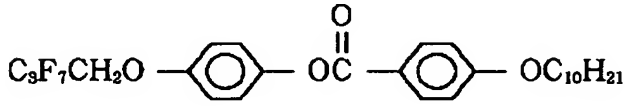
[0057]

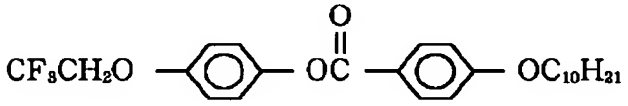
[Formula 10]

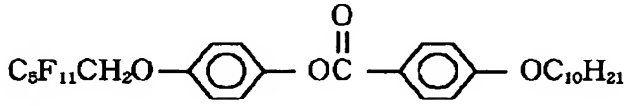
I－1 

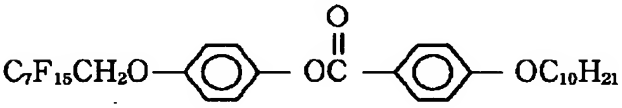
I－2 

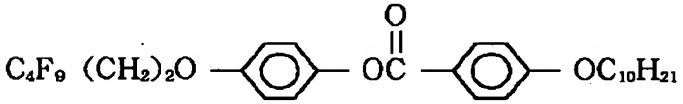
I－3 

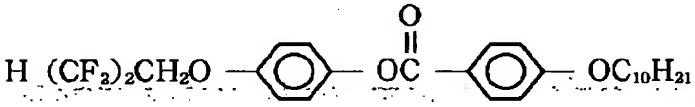
I－4 

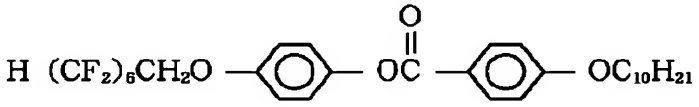
I－5 

I－6 

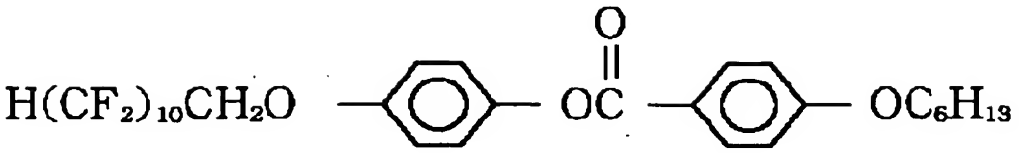
I－7 

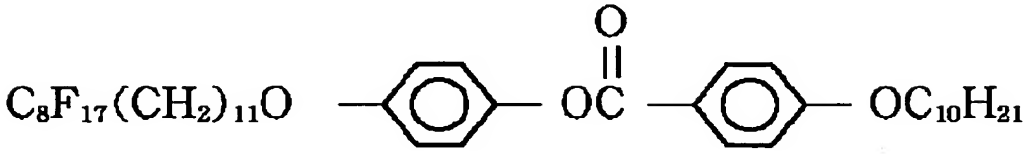
I－8 

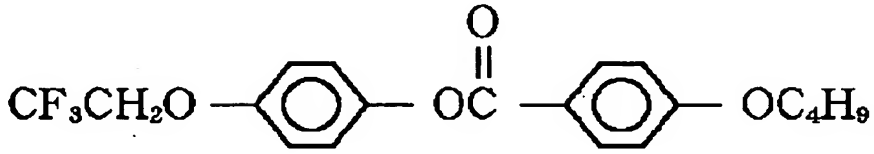
I－9 

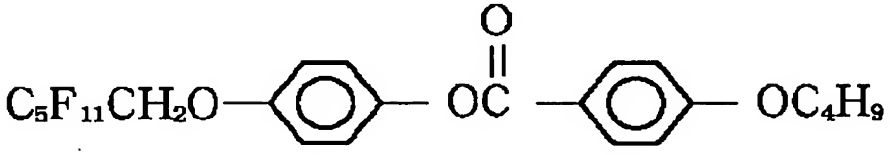
I－10 

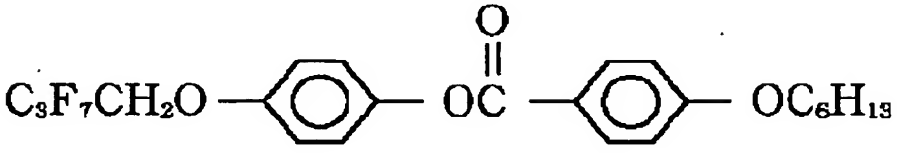
[0058]
[Formula 11]

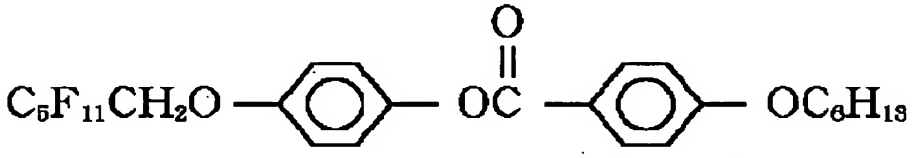
I－11 

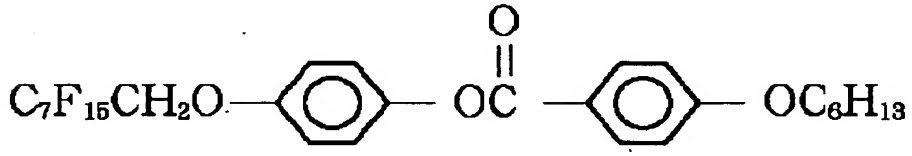
I－12 

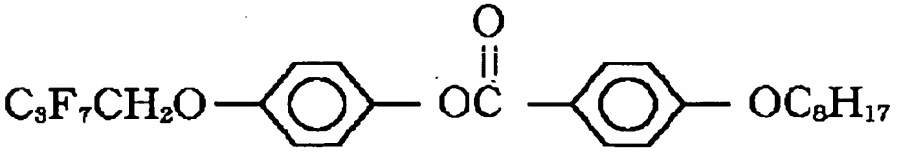
I－13 

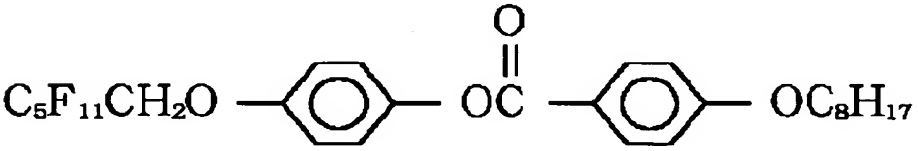
I－14 

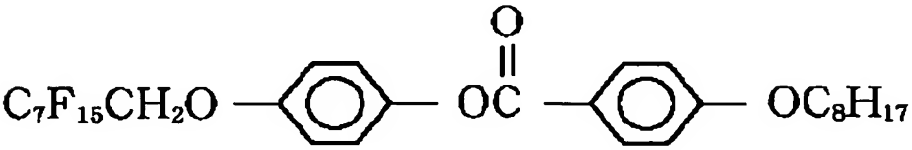
I－15 

I－16 

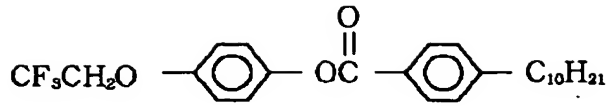
I－17 

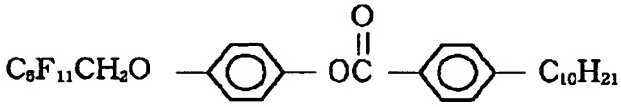
I－18 

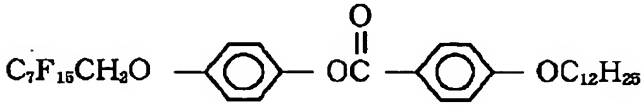
I－19 

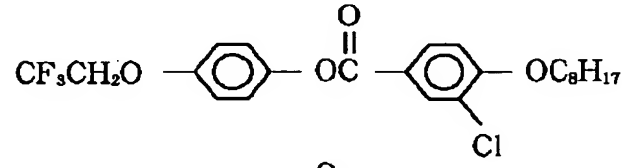
I－20 

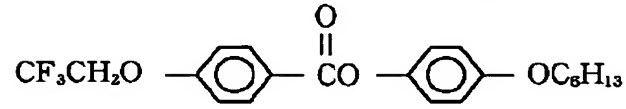
[0059]
[Formula 12]

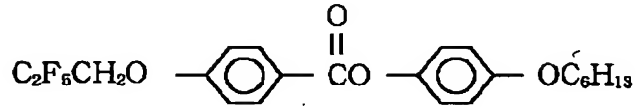
I – 21 

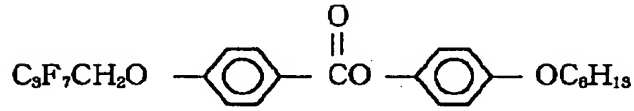
I – 22 

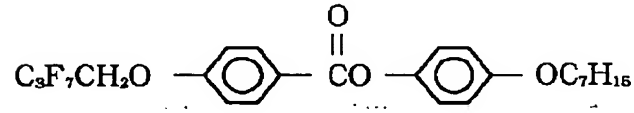
I – 23 

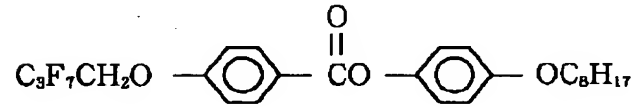
I – 24 

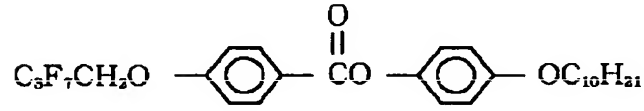
I – 25 

I – 26 

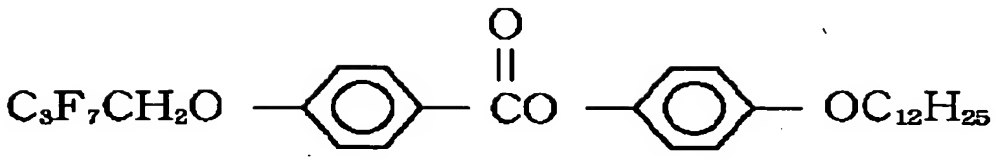
I – 27 

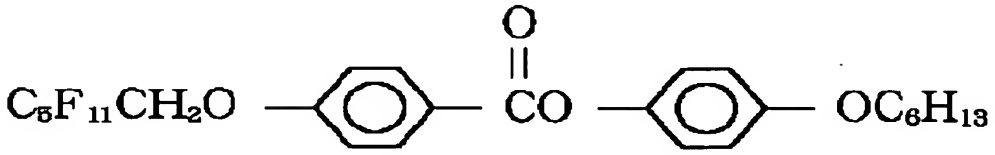
I – 28 

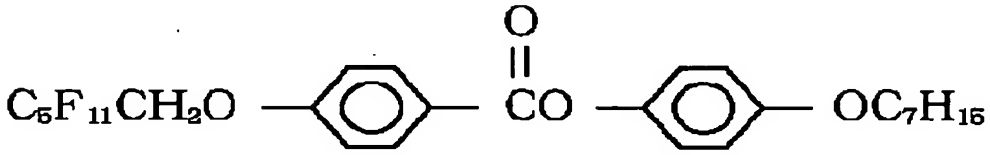
I – 29 

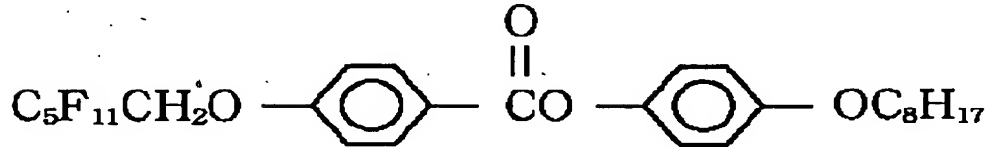
I – 30 

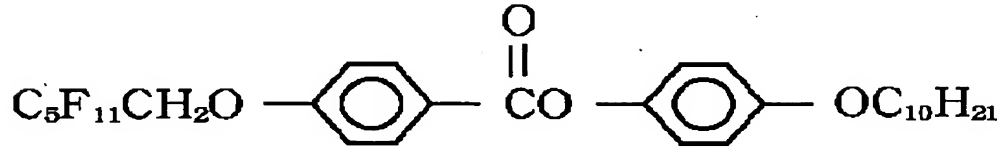
[0060]
[Formula 13]

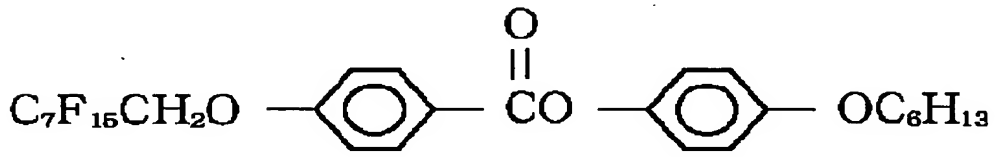
I − 31 

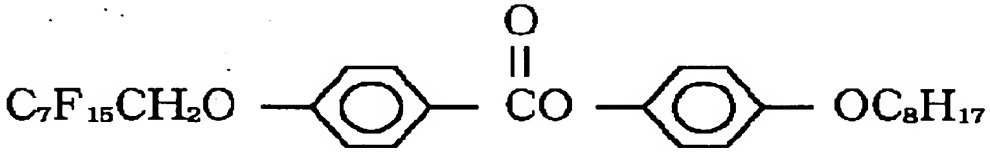
I − 32 

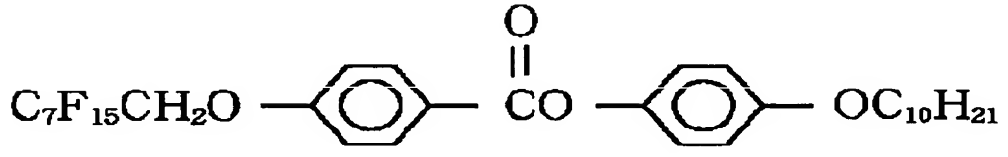
I − 33 

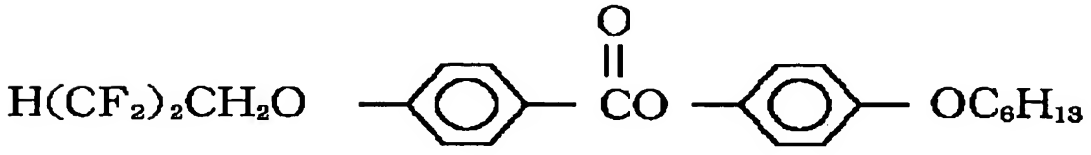
I − 34 

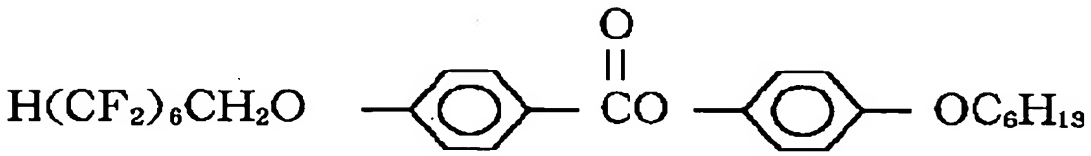
I − 35 

I − 36 

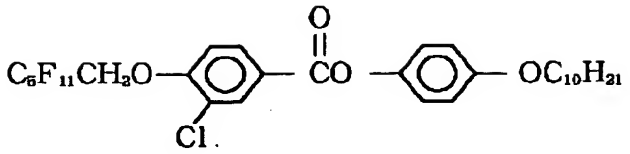
I − 37 

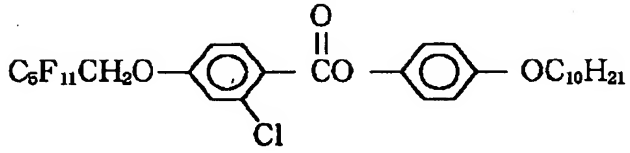
I − 38 

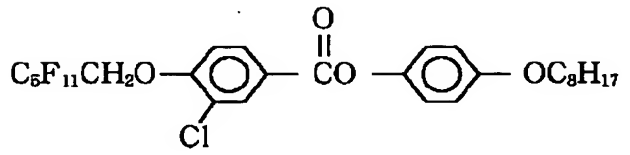
I − 39 

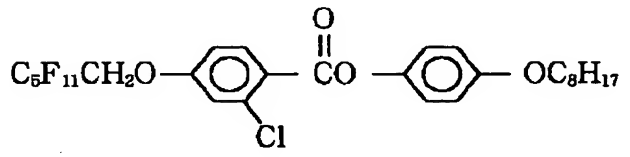
I − 40 

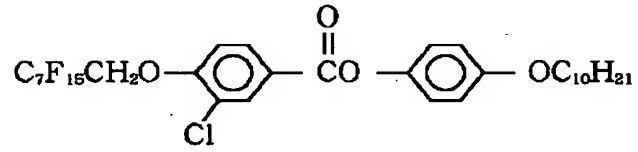
[0061]
[Formula 14]

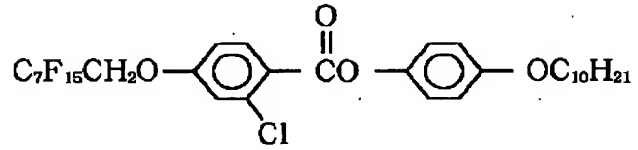
I－41 

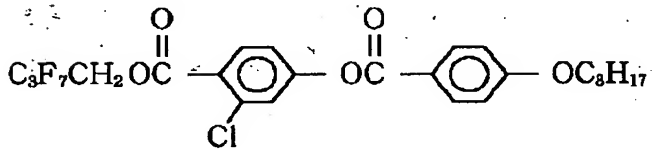
I－42 

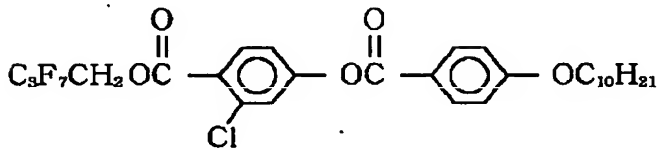
I－43 

I－44 

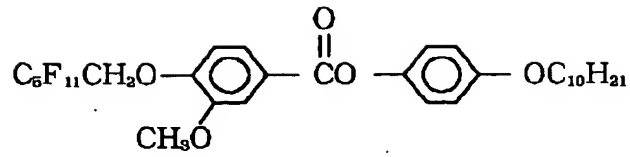
I－45 

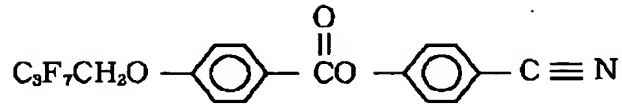
I－46 

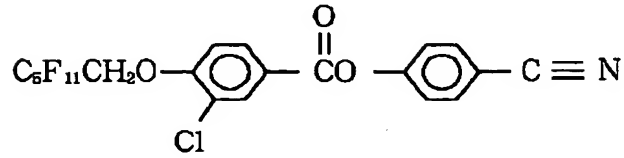
I－47 

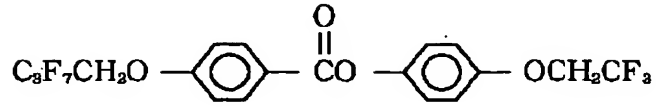
I－48 

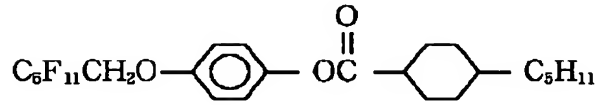
[0062]
[Formula 15]

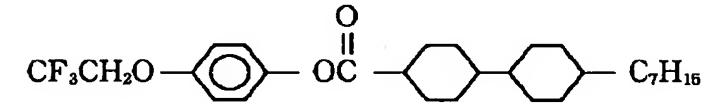
I－49 

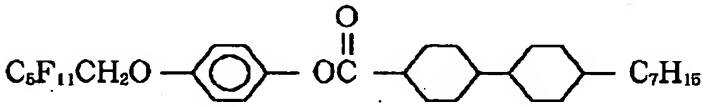
I－50 

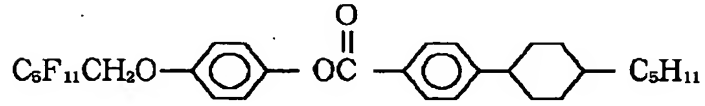
I－51 

I－52 

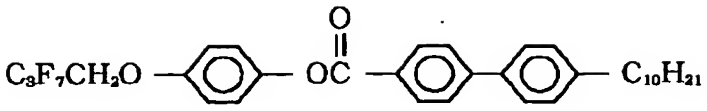
I－53 

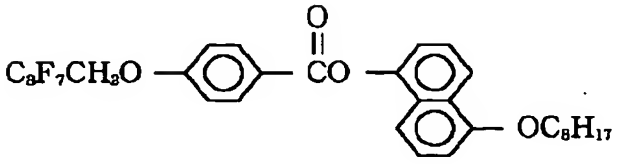
I－54 

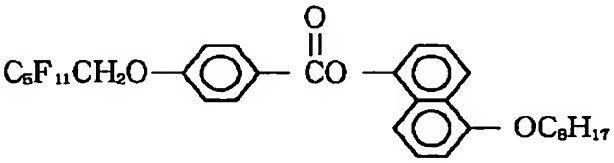
I－55 

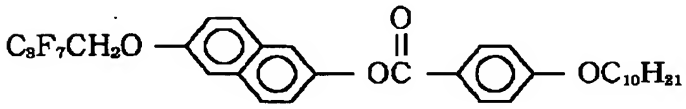
I－56 

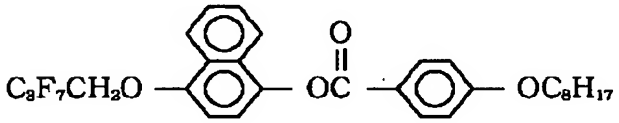
[0063]
[Formula 16]

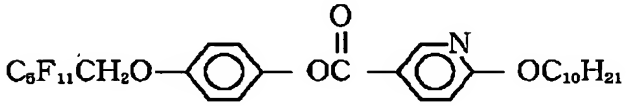
I – 57 

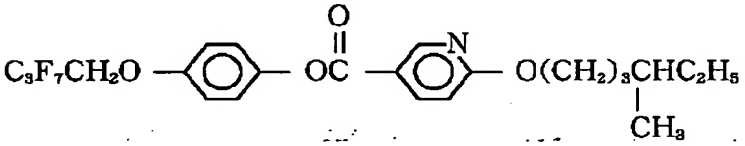
I – 58 

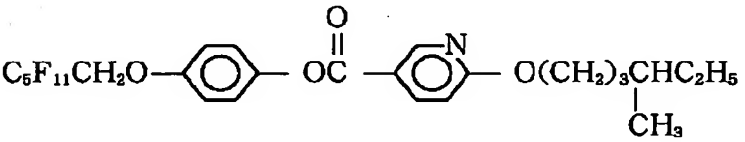
I – 59 

I – 60 

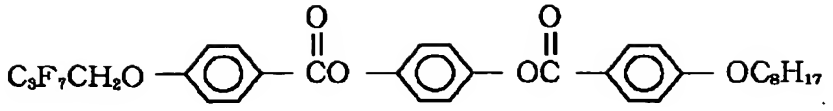
I – 61 

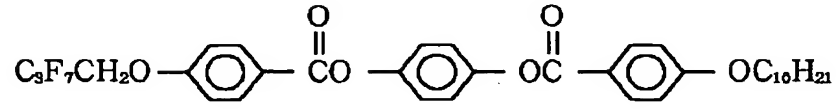
I – 62 

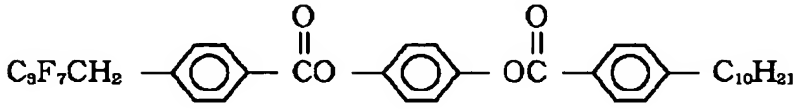
I – 63 

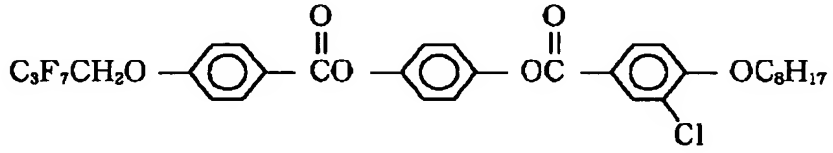
I – 64 

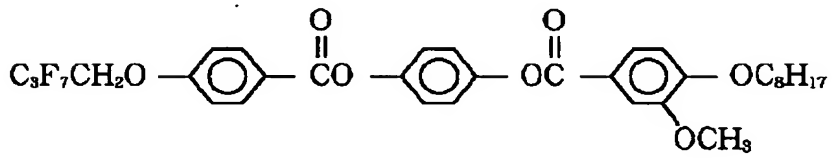
[0064]
[Formula 17]

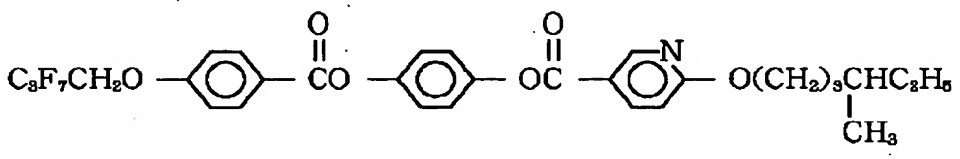
I－65 

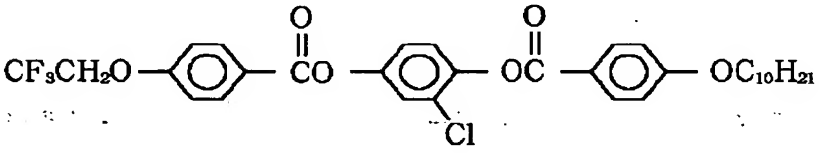
I－66 

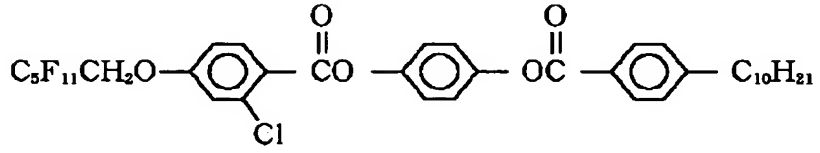
I－67 

I－68 

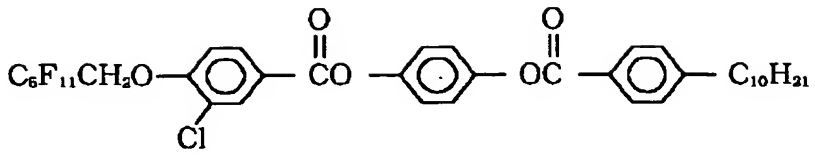
I－69 

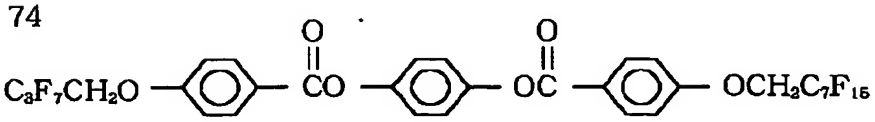
I－70 

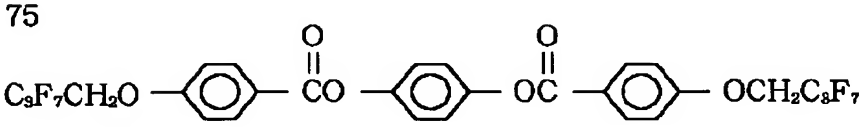
I－71 

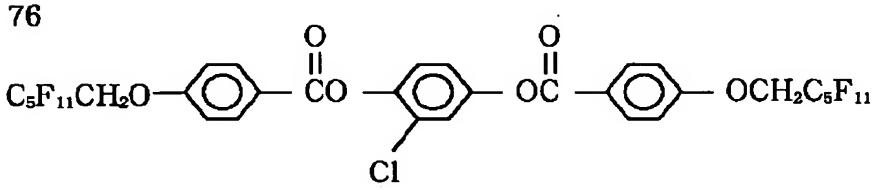
I－72 

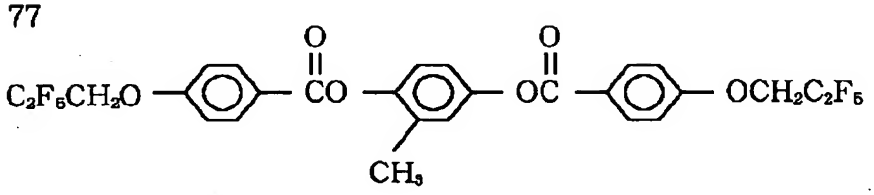
[0065]
[Formula 18]

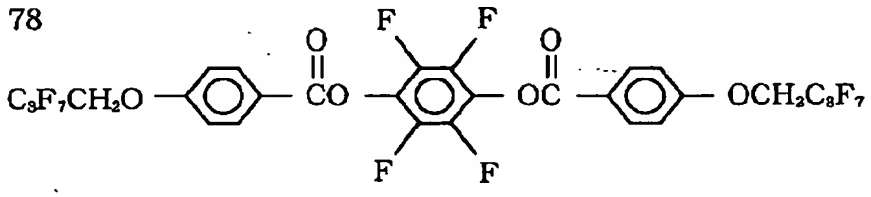
I－73 

I－74 

I－75 

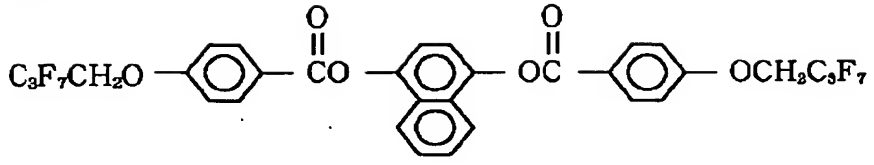
I－76 

I－77 

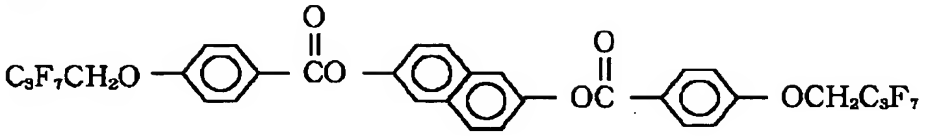
I－78 

[0066]
[Formula 19]

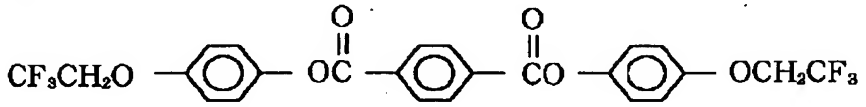
I－79



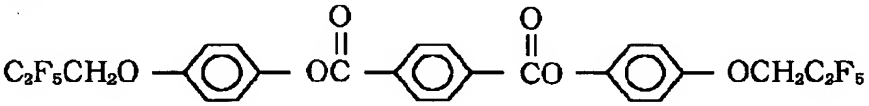
I－80



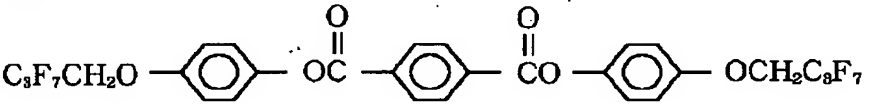
I－81



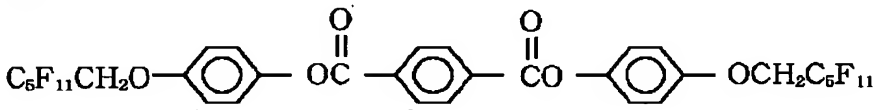
I－82



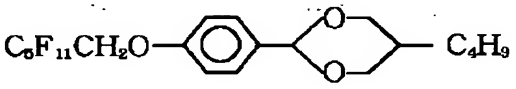
I－83



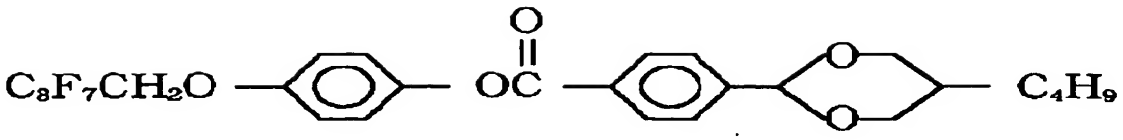
I－84

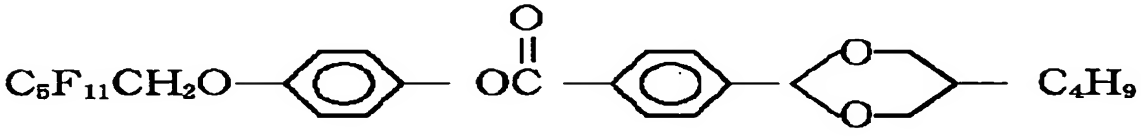


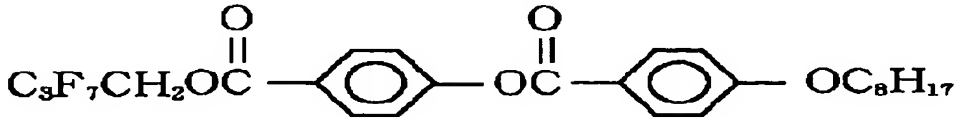
I－85

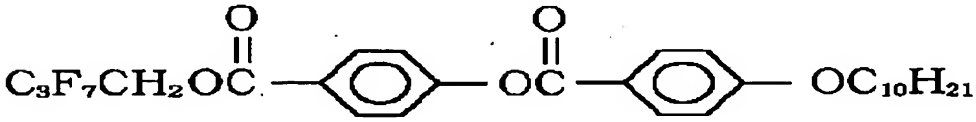


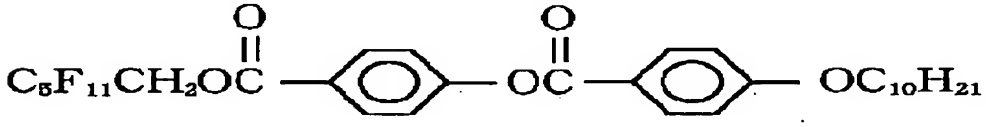
[0067]
[Formula 20]

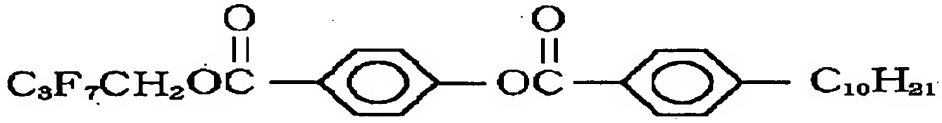
I — 86 

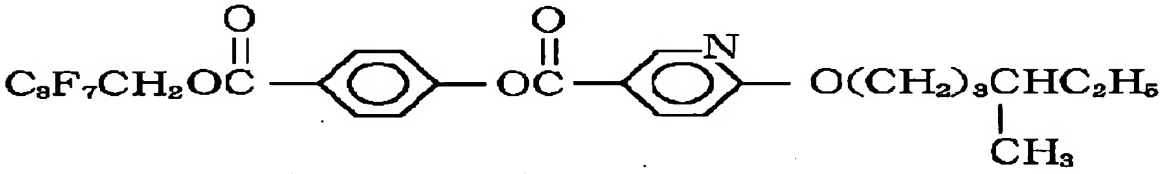
I — 87 

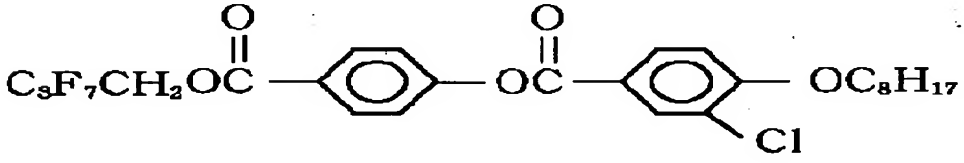
I — 88 

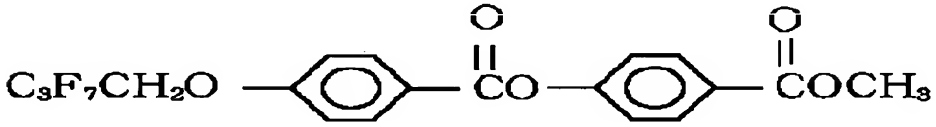
I — 89 

I — 90 

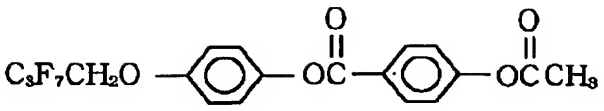
I — 91 

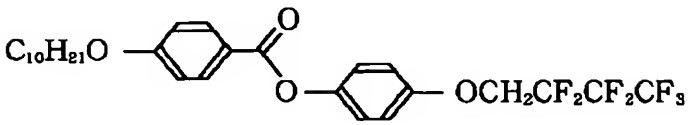
I — 92 

I — 93 

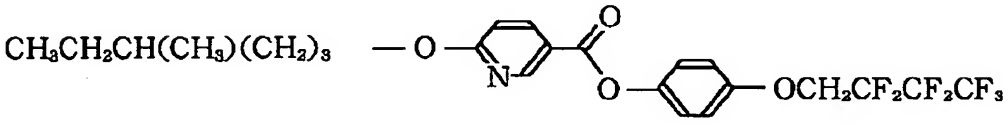
I — 94 

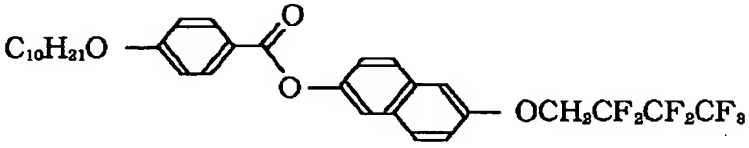
[0068]
[Formula 21]

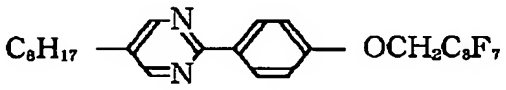
I－95 

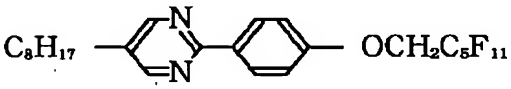
I－96 

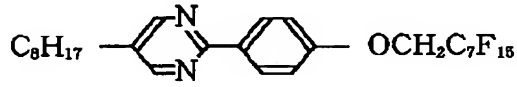
I－97

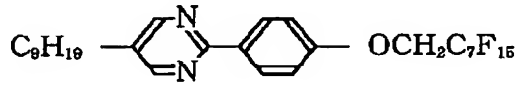


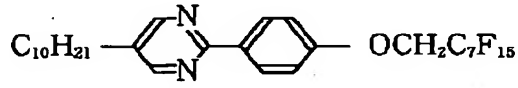
I－98 

I－99 

I－100 

I－101 

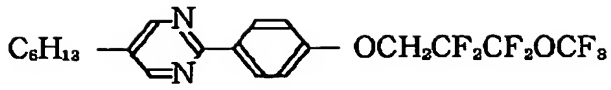
I－102 

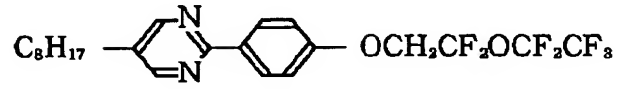
I－103 

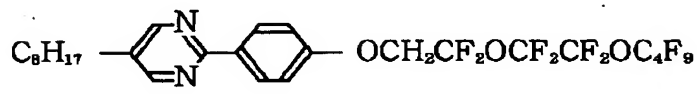
[0069] The compound expressed with the above-mentioned general formula (II) can be obtained by the approach the international disclosure WO 93/22396 and given in a Patent Publication Heisei 7-No. 506368 official report. The examples of this compound are enumerated below.

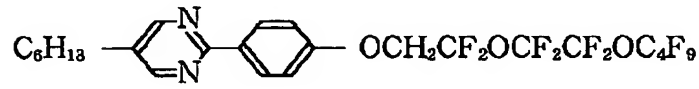
[0070]

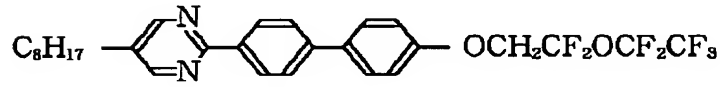
[Formula 22]

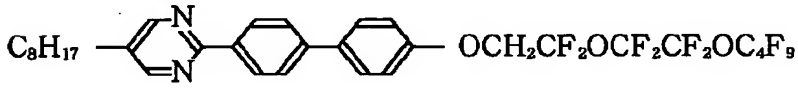
II－1 

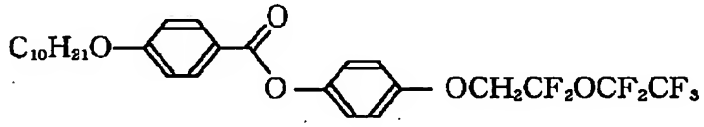
II－2 

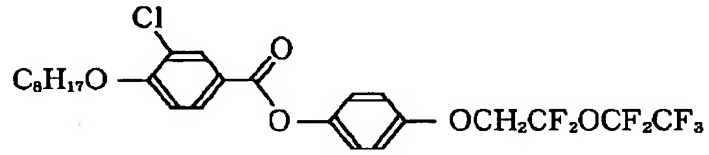
II－3 

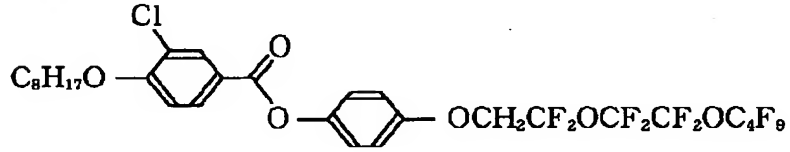
II－4 

II－5 

II－6 

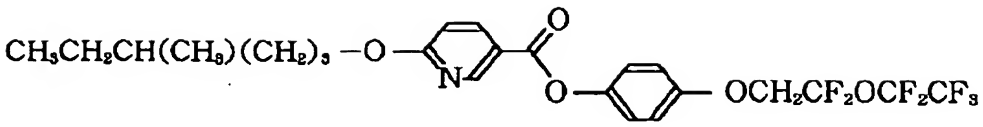
II－7 

II－8 

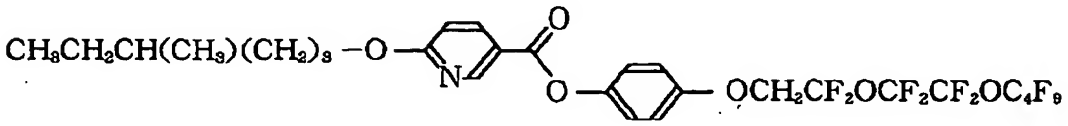
II－9 

[0071]
[Formula 23]

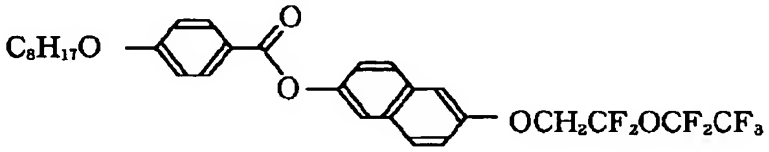
II－10



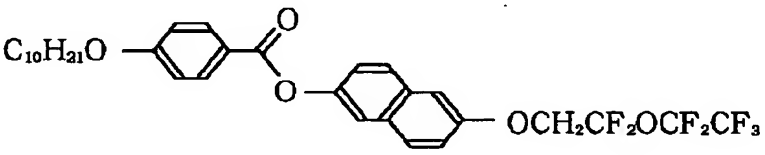
II－11



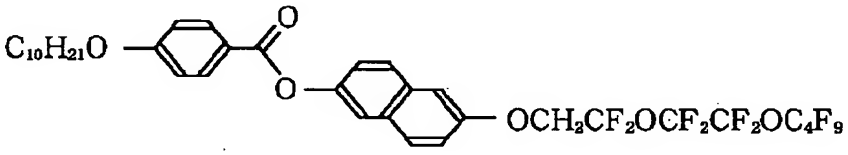
II－12



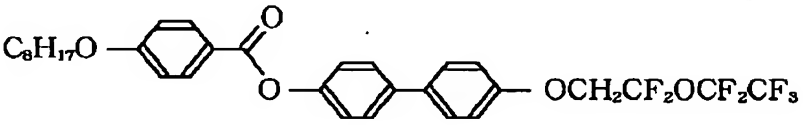
II－13



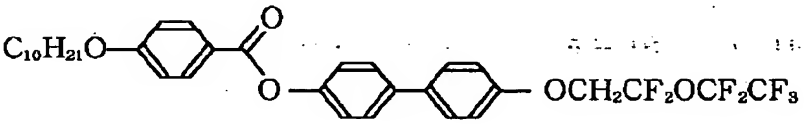
II－14



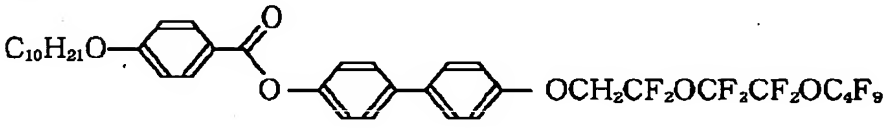
II－15



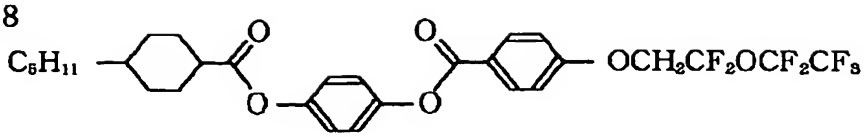
II－16

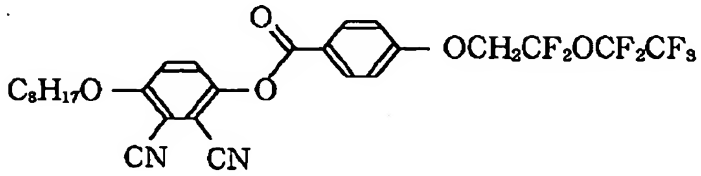


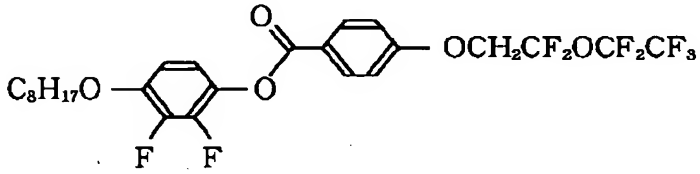
II－17

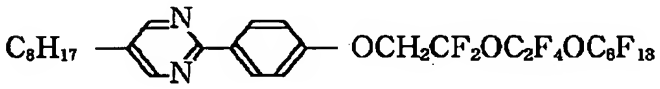


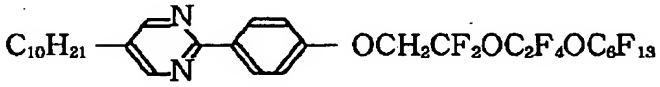
[0072]
[Formula 24]

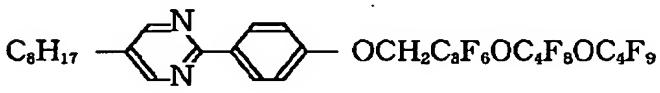
II－18 

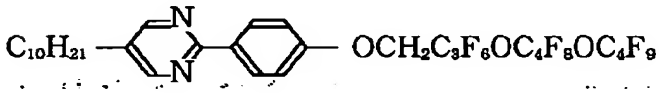
II－19 

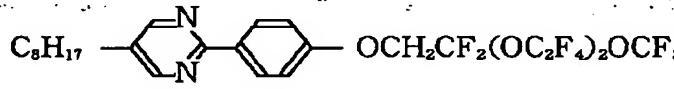
II－20 

II－21 

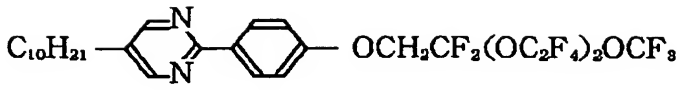
II－22 

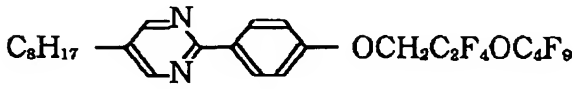
II－23 

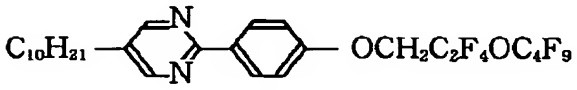
II－24 

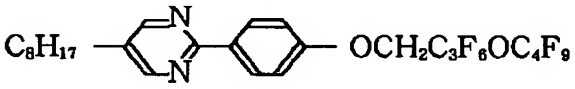
II－25 

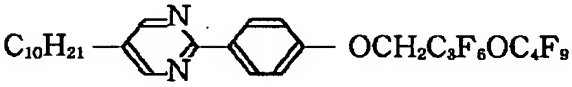
[0073]
[Formula 25]

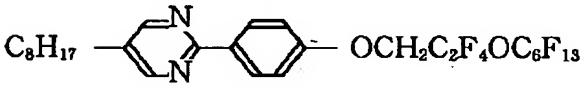
II − 26 

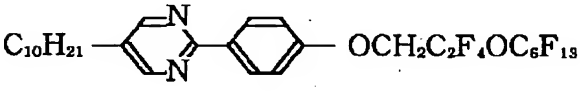
II − 27 

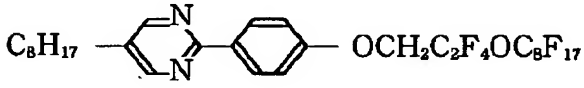
II − 28 

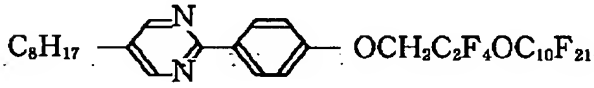
II − 29 

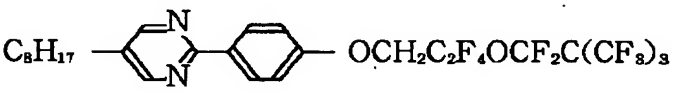
II − 30 

II − 31 

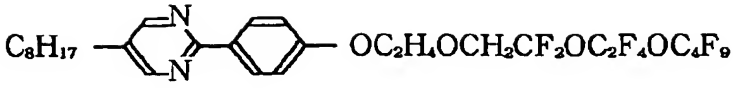
II − 32 

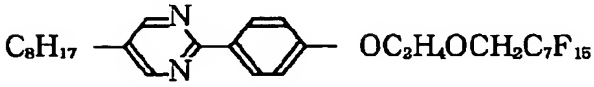
II − 33 

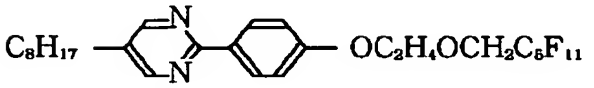
II − 34 

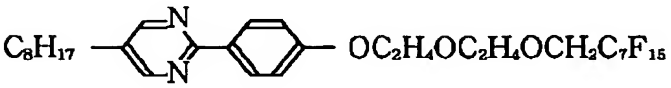
II − 35 

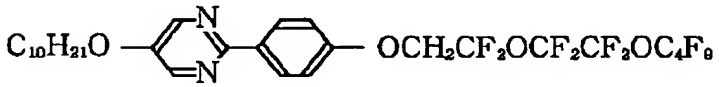
[0074]
[Formula 26]

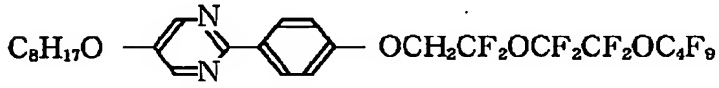
II − 36 

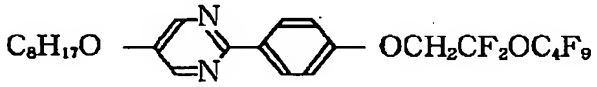
II − 37 

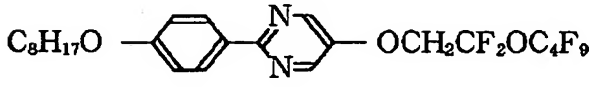
II − 38 

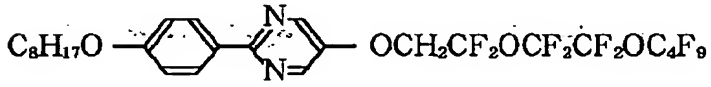
II − 39 

II − 40 

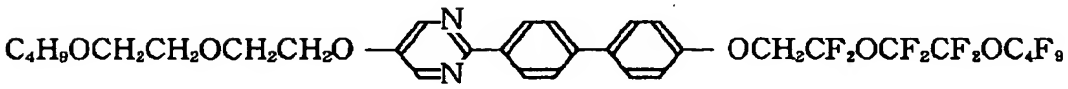
II − 41 

II − 42 

II − 43 

II − 44 

II − 45



[0075] In the chiral smectic liquid crystal used for this invention, it is possible to make additives, such as other compounds, for example, a color, a pigment, an antioxidant, and an ultraviolet ray absorbent, contain.
 [0076] The configuration of the liquid crystal device of this invention is not restricted to the configuration of the above-mentioned operation gestalt, and if it is a configuration applied to a conventional liquid crystal device, especially a conventional chiral smectic liquid crystal device, it is applicable suitably.

[0077] In this invention, the liquid crystal heated, for example to the isotropic phase in the cel of the configuration of the above-mentioned operation gestalt is poured in, and temperature up and one or more cycles of temperature fall processes are preferably given more than a two cycle in a SmC* phase (or SmCA phase).

[0078] In this invention, the temperature requirement of temperature up and a temperature fall is set up within limits to which the minimum made -20 degrees C or more and an upper limit temperature low 0.5 degrees C from the phase transition temperature from a phase (for example, smectic A phase) to a higher order chiral smectic phase in the temperature requirement which shows a chiral smectic phase. Moreover, temperature width of temperature up or a temperature fall is preferably made into about 10-50 degrees C.

[0079] In this invention, the smectic layer system was analyzed with the following X-ray diffraction method.
[0080] Fundamentally, it asked for the interlayer spacing d and the tilt angle delta of a smectic layer by the approach [Japan display (Japan Display)'86, Sep.30-Oct.2, 1986.456-458] performed by Clerks and Lagerwall. In order for a liquid crystal cell to make heat capacity small using what equipped with automatic-temperature-control equipment the X-ray diffractometer (MAC Saiensu-Sha make) with which a measuring device has the revolution cathode method X-ray generating section and to reduce absorption of the X-ray to a glass substrate, the micro sheet (80-micrometer thickness) by Corning, Inc. was used for the substrate.
[0081] First, using what applied as a sample bulk liquid crystal (liquid crystal constituent injected into a cel) so that a front face might become smooth on 5mm square at a glass substrate, the interlayer spacing d applied the peak acquired by the usual powder X-ray diffractometry to Bragg's (Bragg) diffraction conditional expression, and it asked for it.
[0082] Since the smooth nature of a diffraction side is increased, after making measurement temperature into the temperature from which each liquid crystal constituent will be in an isotropic liquid condition, it dropped temperature for every degree C 3 degrees C and near the changing point, and it measured to the temperature from which a diffraction peak is no longer acquired. The automatic-temperature-control equipment used for the experiment showed the control precision of about **0.3 degrees C at each temperature.
[0083] Next, the X-ray detector was set by angle-of-diffraction 2theta equivalent to the interlayer spacing which searched for the smectic layer system formed in the cel previously, theta scan of a cel was done, and it asked by the approach shown in said reference.
[0084] The setups of the above-mentioned X-ray diffractometer are X-ray output =45kVx30mA=13.5kW, divergent slit:0.5 degree, scan slit:0.5 degree, light-receiving slit:0.15mm, and scan speed:8 degrees /, and min, using copper kappa alpha rays as the analytical line, exposure area is decided by the cel fixture and the slit, and it is 2 8.0x1.8mm. Cel thickness is 2.0 micrometers. In addition, the Sonneveld method was used for the background cut-off.
[0085] Although the liquid crystal device of this invention can be used for liquid crystal equipment with various functions, the example for which were most suitable realizes a liquid crystal display by using this component for the display-panel section, and taking the communication link synchronous means by the data format and SYN signal which consist of image information with drawing 2 and the scanning-line address information shown in 3. the sign in drawing -- 101 -- a liquid crystal display and 102 -- a graphic controller and 103 -- a display panel and 104 -- a scanning-line actuation circuit and 105 -- an information line actuation circuit and 106 -- a decoder and 107 -- a scanning-line signal generating circuit and 108 -- for an actuation control circuit and 112, GCPU and 113 are [a shift register and 109 / line memory and 110 / an information signal generating circuit and 111 / the host CPU and 114] VRAMs.
[0086] Generating of image information is performed by the graphic controller 102 of the main frame, and it is transmitted to a display panel 103 according to the signal means of communication shown in drawing 2 and drawing 3 . The graphic controller 102 manages management and a communication link of the image information between the host CPU 113 and a liquid crystal display 101 for GCPU (central processing unit)112 and VRAM (memory for image information storing)114 in the nucleus. In addition, the light source is arranged in the rear face of this display panel.
[0087] Since the indicating equipment of this invention has the large actuation margin which the orientation unevenness of the liquid crystal device which is a display medium is controlled, and is mentioned later, it can demonstrate the outstanding actuation property and can obtain the display image of a high definition, a high speed, and a large area.
[0088] As a method of driving the liquid crystal device of this invention, the method of driving a publication can be used for JP,59-193426,A, a 59-193427 official report, a 60-156046 official report, and a 60-156047 official report, for example.
[0089] Hereafter, with reference to a drawing, the matrix actuation in the liquid crystal device of this invention and the actuation property which becomes important in that case are explained.
[0090] Drawing 4 is the top view of an example of the liquid crystal panel which has arranged the matrix electrode. In this drawing, the scanning line (S1 - Sm) of the scan electrode group 62 and the data line (I1 -In) of the information electrode group 63 intersect a liquid crystal panel 61 mutually, it wires, and liquid crystal is arranged between the scanning line and the data line. And each intersection of the scanning line and the data line serves as a pixel which is 1 display unit, an electrical potential difference is impressed from the scanning line and the data line, and actuation of liquid crystal is made.
[0091] Drawing 5 and drawing 6 are wave-like examples of the driving method (multiplexer actuation)

adopted in the matrix electrode structure shown in drawing 4 .
[0092] The actuation wave shown in drawing 5 is a wave of the reset write-in mold which considered as setting out which indicates by black with the polarity by the side of + on the basis of a scanning-line side, and made the black display side the reset direction. Inside S0 of drawing It is the scan signal wave form impressed to the scanning line I1 It is the information signal wave (white display wave) impressed to the data line I2 The information signal wave (black display wave) impressed to the data line is expressed, respectively. Moreover, the inside of drawing (S0-I1) and (S0-I2) are the voltage waveforms impressed to the selected pixel, the pixel to which the electrical potential difference (S0-I1) was impressed will be in a white display condition, and the pixel to which the electrical potential difference (S0-I2) was impressed will be in a black display condition (reset is made into a black display side as mentioned above).
[0093] drawing 6 -- it can set (S2-I0) -- (S3-I0) is the actuation wave shown in drawing 5 , for example, it is a time series wave impressed to the 2nd pixel when performing a "white, white, black, and black" display to 4 pixels which continues on the same data line, and the 3rd pixel.
[0094] In the actuation wave shown in drawing 5 and drawing 6 , the pulse which a reset pulse clear one line is set as delta(5/2) t, and assists a reset pulse side after a write-in pulse is doing delta(1/2) t existence of to write-in pulse width deltat impressed to the pixel on the selected scanning line. For this reason, in the actuation wave shown by drawing 5 and drawing 6 , an one-line scan period (1H) is set to 4deltat. However, it is also possible to establish the time amount which it scans, without establishing the time amount which overlaps a scan wave for every line like drawing 6 , and also overlaps an output in the scan wave of the two or more scanning lines (for example, adjoining scanning line) (for example, 2delta t minutes), and to shorten a practical one-line scan time (1H) (to for example, 2deltat).
[0095] The value of each parameter [of an actuation wave], scan signal-level VS and information signal electrical potential difference VI, driver voltage Vop=VS+VI, and bias ratio =VI/(VS+VI), and deltat is determined by the switching characteristic of the liquid crystal ingredient to be used. [which were shown in drawing 5 and drawing 6]
[0096] Using the actuation wave shown by drawing 5 , drawing 7 fixes an above-mentioned bias ratio to 1/3.4, and fixes driver voltage Vop by 20V, and shows change of the final permeability T after the actuation wave impression in the applicable pixel at the time of changing pulse width deltat (after selection impression).
[0097] In this drawing, it is permeability when, as for the continuous line, the white display wave (S0-I1) (black elimination (reset), white writing) was impressed and, as for a wavy line, a black display wave (S0-I2) (black elimination (reset), black maintenance) is impressed.
[0098] In the case where the white display wave (S0-I1) of a continuous line is impressed Before the wave of an applicable pixel is impressed, the condition is in the black display condition, and it is deltat1. The writing to a white display condition has come be thoroughly made in the above pulse width. deltat2 In big deltat, the writing to a white display condition is impossible again (since it will be in a black display condition again by impression of the auxiliary pulse of the reversed polarity which follows the pulse of W of a white display wave (S0-I1) shown in drawing 5).
[0099] moreover, in the black display wave (S0-I2) of a wavy line Before the wave of an applicable pixel is impressed, the condition is in the reverse white display condition. deltat3 The reset and maintenance to a black display condition are thoroughly realized with the above pulse width, and it is deltat4. In delta t [big] Maintenance of a black display condition is impossible (it will be in a white display condition by the impression of the maintenance pulse of the reversed polarity which follows B pulse of a black display wave (S0-I2) shown in drawing 5 itself).
[0100] deltat3<deltat1 [usually,] it is -- since -- deltat1 Threshold pulse width, a call, and deltat2 The smaller one (the case of drawing 7 delta t4) of deltat4 is called cross talk pulse width (white cross talk pulse width and deltat4 are also called black cross talk pulse width for deltat2).
[0101] Matrix actuation is made by the actuation wave with the pulse width between threshold pulse width and cross talk pulse width, the positive white display by the white display wave (white display wave of drawing 5 (S0-I1)) and the positive black display by the black display wave (black display wave of drawing 5 (S0-I2)) are attained, and white and good black image display can be performed only with the polar difference of an information signal.
[0102] By enlarging an above-mentioned bias ratio, it is deltat2. deltat4 Although it is possible to enlarge the value of cross talk pulse width, it causes [mean enlarging width of face of an information signal, and] buildup with a bee, and lowering of contrast in image quality and is not desirable to increase a bias ratio. According to this invention person's etc. examination, about 1 / three to 1/5 were suitable for the bias ratio.
[0103] Above-mentioned threshold pulse width deltat1 as an index for evaluating this quantitatively, although the property about how much allowances are in setting out of actuation conditions is called an

actuation margin about such an actuation property The parameter [M2] which expresses the width of face from the central value of the value of the cross talk pulse width deltat4 (it is deltat2 depending on the case) with a ratio can be used.

[0104]

M2=(deltat4-deltat1)/(deltat4+deltat1)

[0105] In a certain constant temperature, the actuation margin with possible and writing black and two white conditions in a selection pixel with two kinds of sense of an information signal as mentioned above and possible a non-choosing pixel holding the condition of the black or white has a difference by the liquid crystal ingredient and the component configuration; and is characteristic. Moreover, also by change of environmental temperature, since these actuation margins differ, they need to set up the optimal actuation conditions to a liquid crystal ingredient, and a component configuration and environmental temperature with a actual liquid crystal display. Naturally as a display device, it is so advantageous that the above-mentioned actuation margin parameter M2 is large.

[0106] In addition, although driver voltage Vop was fixed and pulse width deltat was changed about assessment of the actuation property (actuation margin) shown in drawing 7 , pulse width deltat may be fixed reversely, driver voltage Vop may be changed, and both parameters may be changed.

[0107]

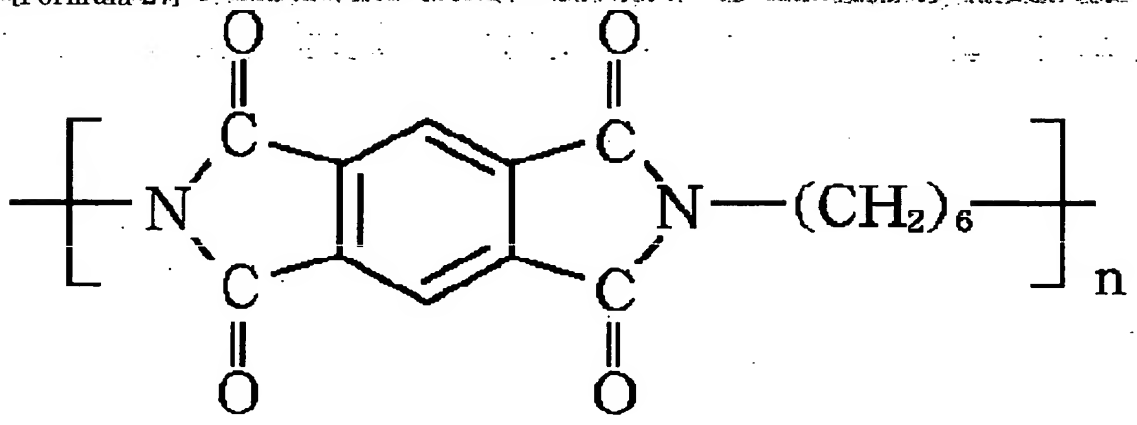
[Example] Using a glass substrate as a substrate, an ITO target is used with respectively common DC sputtering system, and it is Ar:90SCCM and O2 as power 1W/cm2 and sputtering gas. : The ITO film of 700A thickness was deposited for 10SCCM by the sink and discharge for 2.5 minutes. Patterning of this ITO film was carried out to the shape of a 1cmx1cm square by the usual wet etching, and it considered as the electrode.

[0108] On one electrode substrate, it is SiOx. In the silicon oxide base material which consists of a polymer, it is SnOx of an antimony dope. The solution which distributed the oxide ultrafine particle was applied on the spin conditions of 1000rpm and 10sec, and the film with a thickness of 1500A was formed. Then, 200 degrees C and baking for 60 minutes were performed, and the orientation control layer A was formed.

[0109] The spin coat of the polyimide which has the following repeat unit diluted with the mixed liquor (2:1) of NMP (N-methyl pyrrolidone) and nBC (n-butyl cellosolve) (0.5 % of the weight) was carried out to the electrode substrate of another side on condition that 500rpm, 15sec and 1500rpm, and 30sec, this was calcinated for 60 minutes at 200 degrees C, and the polyimide film with a thickness of 50A was formed. Then, 1000rpm, the amount of pushing of 0.4mm, delivery speed 50 mm/sec, and rubbing processing of two uni directionals were performed to the above-mentioned polyimide film, and the orientation control layer B was formed.

[0110]

[Formula 27]



[0111] then, the above-mentioned orientation control layer B top -- SiO2 of the diameter of 2.4 micrometer a spin coat carries out afterbaking of the particle content solution, and distributed fixing is carried out -- making -- succeedingly -- the adhesion particle (particle size of about 5 micrometers) solution by Toray Industries, Inc. -- a spin coat -- distributed fixing was heated and carried out.

[0112] On the other hand, on the orientation control layer A, it applied to the location of a request of a sealant using the printing machine, and this was prebaked for 5 minutes at 90 degrees C.

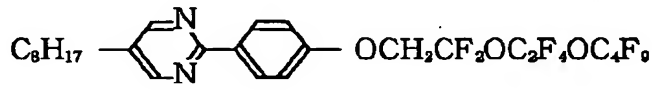
[0113] Lamination and a press machine are used for two above-mentioned substrates, and they are 50 gf/cm2. It was stuck by pressure by the pressure. Where the still more nearly same pressure is applied

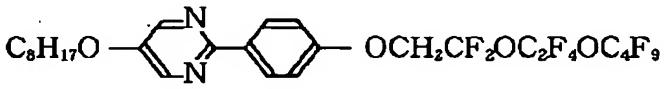
with an air cushion, 150 degrees C and heating for 90 minutes were performed, and the sealant was stiffened. In addition, the cel has been arranged between the polarizing plates of a couple a couple and a polarization value cross at right angles mutually.

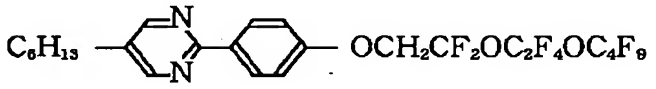
[0114] Then, after it put in the empty cel produced by the above-mentioned activity in the vacuum chamber of the usual load lock type and it carried out vacuum suction to the 1.0x10-3Pa grade, it dipped so that an inlet might be attached to the liquid crystal depot heated at 85 degrees C in the about 1.0Pa vacuum, and liquid crystal was poured in into the component, and the liquid crystal device was produced. In addition, in this example, liquid crystal constituent FLC-1 was adjusted using following liquid crystal compound (a) - (d), and this was used. Moreover, this cel has been arranged between the polarization shafts of the couple the couple and the polarization shaft crossed at right angles mutually.

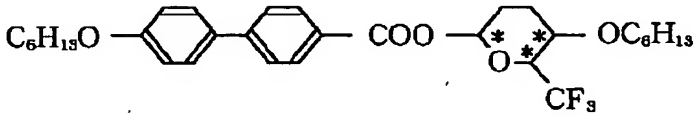
[0115]

[Formula 28]

(a) 

(b) 

(c) 

(d) 

重量部

FLC－1　(a)：(b)：(c)：(d) ＝60：15：15：6

相転移温度　Iso. ⟶ SmA ⟶ SmC *

(℃)　77　47

自発分極（Ps）（30℃）＝27.0nC／cm²

チルト角（Θ）（30℃）＝24°

d_{min}/d_{max} ＝0.993

[0116] In addition, the spontaneous polarization (Ps) of above-mentioned liquid crystal constituent FLC-1 K. -- others [Miyasato] "the direct measurement approach of the spontaneous polarization of the ferroelectric liquid crystal by the chopping sea" (Japanese Journal of Applied Physics --) No. 22 or 10 (661) 1983 and "Direct Method with Triangular Waves for Measuring Spontaneous Polarization in Ferroelectric Liquid Crystal", as described by KMiyasato et By al. (Jap.J.Appl.Phys.22.No.10, L661 (1983)) It measured.

[0117] Moreover, it asked for the tilt angle (theta) of above-mentioned liquid crystal constituent FLC-1 as follows. That is, the 1st extinction position (location where permeability becomes the lowest) and 2nd extinction position are searched for, detecting an optical response by photograph mull (the Hamamatsu photonics company make) at the same time it makes a polarizing plate and parallel rotate the liquid crystal device arranged under a rectangular cross Nicol's prism in the meantime, impressing AC (**30-**50V and 1-100Hz) (alternating current) through an electrode between the vertical substrates of a liquid crystal device. And one half of the include angles from the 1st extinction position at this time to the 2nd extinction position is set to tilt angle theta.

[0118] At this example, it processed on two kinds of following conditions to the above-mentioned liquid

crystal device.
80 degrees C [of examples] -> 25 degrees C (-1 degree C / min)
25 degrees C -> 45 degrees C (1 degree C / min)
45 degrees C -> 30 degrees C (-1 degree C / min)
80 degrees C [of examples of a comparison] -> 30 degrees C (-1 degree C / min)
[0119] By approach which mentioned above the actuation margin in 30 degrees C of the above-mentioned liquid crystal device, it measured using the actuation wave (VOP=20V, a bias ratio = white and black are displayed by the single pixel 1/3.3, duty ratio =1 / about [1000]) shown in drawing 5 and drawing 6 . The liquid crystal device of an example was [0.230 and the example of a comparison] 0.155, and as for the parameter M2 which shows an actuation margin, according to this invention, it turned out that the actuation margin has been improved substantially.
[0120]
[Effect of the Invention] As explained above, according to this invention, in a chiral smectic liquid crystal device, orientation unevenness is controlled, as a result, a liquid crystal device with a large actuation margin is obtained, and it becomes possible to constitute the display of a high definition and a high speed excellent in the display property, and a large area.

[Brief Description of the Drawings]
[Drawing 1] It is the cross section of 1 operation gestalt of the liquid crystal device of this invention.
[Drawing 2] It is the block diagram showing the liquid crystal display equipped with the liquid crystal device of this invention, and a graphic controller.
[Drawing 3] It is drawing showing the image information communication link timing chart between a liquid crystal display and a graphic controller.
[Drawing 4] It is the top view of the liquid crystal panel which has arranged the matrix electrode.
[Drawing 5] It is drawing showing an example of an actuation wave used for actuation of the liquid crystal device of this invention.
[Drawing 6] It is drawing showing an example of an actuation wave used for actuation of the liquid crystal device of this invention.
[Drawing 7] It is drawing having shown pulse width deltat at the time of using the actuation wave of drawing 5 , and the relation of permeability T.
[Description of Notations]
1a, 1b Substrate
2a, 2b Electrode
3 Four Orientation control layer
61 Display Panel
62 Scan Electrode Group
63 Information Electrode Group
101 Liquid Crystal Display
102 Graphic Controller
103 Display Panel
104 Scanning-Line Actuation Circuit
105 Information Line Actuation Circuit
106 Decoder
107 Scanning-Line Signal Generating Circuit
108 Shift Register
109 Line Memory
110 Information Signal Generating Circuit
111 Actuation Control Circuit
112 GCPU
113 Host CPU
114 VRAM

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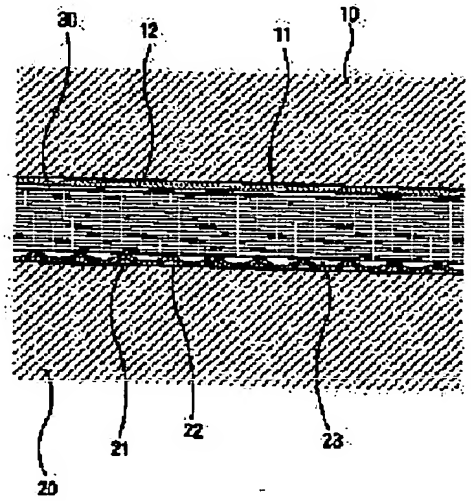
最終頁に続く

(54)【発明の名称】　反射型液晶表示装置及びその製造方法

(57)【要約】
【課題】　反射面の反射率や液晶層の透過率を下げることなく、表示の明るさ及びコントラストを保持しつつ、高い視認性を得ることのできる反射型液晶表示装置の構造を提供する。
【解決手段】　基板２０の内面上に粒状体２５を散布し、適度に分散配置させる。次に、基板２０の内面上の粒状体２５を加熱して溶融させ、図示のように滑らかな凸部２１を成形する。最後に、基板２０の内面上に、及び該内面上に複数形成された凸部２１の表面上に、反射電極層２２を設ける。



【特許請求の範囲】
【請求項１】　一対の基板間に液晶層が挟持されてなり、該一対の基板の一方の基板の液晶層側に反射手段を有する反射型液晶表示装置において、前記一方の基板上には凸部が形成されてなり、該凸部上に前記反射手段が形成されてなることを特徴とする反射型液晶表示装置。
【請求項２】　一対の基板間に液晶層が挟持されてなり、該一対の基板の一方の基板の液晶層側の面に反射手段を有する反射型液晶表示装置において、前記反射手段の上に凸部が形成されてなることを特徴とする反射型液晶表示装置。
【請求項３】　請求項１又は請求項２において、前記凸部は樹脂粒子である反射型液晶表示装置。
【請求項４】　請求項２において、前記凸部は透光性を備えていることを特徴とする反射型液晶表示装置。
【請求項５】　請求項２において、前記凸部は反射性を備えていることを特徴とする反射型液晶表示装置。
【請求項６】　請求項２において、前記凸部は黒色であることを特徴とする反射型液晶表示装置。
【請求項７】　一対の基板間に液晶層を挟持してなる反射型液晶表示装置の製造方法において、前記一対の基板の一方の基板上に複数の粒状体を分散配置し、該粒状体を加熱溶融させて複数の凸部を被着形成し、該凸部上に反射層を形成することを特徴とする反射型液晶表示装置の製造方法。
【請求項８】　一対の基板間に液晶層を挟持してなる反射型液晶表示装置の製造方法において、前記一対の基板の一方の基板上に形成された反射面上に複数の粒状体を分散配置し、該粒状体を加熱溶融させた複数の凸部を形成することを特徴とする反射型液晶表示装置の製造方法。
【請求項９】　請求項７又は請求項８において、前記粒状体は、前記粒状体が通過可能な開口部を備えたマスクを通して分散配置されることを特徴とする反射型液晶表示装置の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は反射型液晶表示装置に係り、特に、液晶表示体の内部に形成される反射面の構造及び製造方法に関する。
【０００２】
【従来の技術】従来、液晶表示装置においては、液晶表示体の内部に反射面を備え、外部から入射した光が液晶層を透過して反射面にて反射され、再び液晶層を透過して放出されるように構成された反射型液晶表示装置がある。
【０００３】反射型液晶表示装置では、表面側の透光性基板と裏面側の基板との間に種々の液晶層が保持されており、液晶層よりも裏面側に反射面が形成される。反射面は、表面側の基板の表面若しくは表面上に形成される場合もあり、また、表面側の基板の内面上に形成される画素電極を反射率の高いＡｌ等の金属電極とすることによって、画素電極と兼用して形成される場合もある。
【０００４】反射型液晶表示装置によれば、外光の反射によって表示を視認できるように構成されているので光源が不要となり、装置の消費電力を低減することができるという利点があるー方、一般的に表示が暗いという問題点がある。表示の明るさを得るためには、反射面の反射率を高めたり、液晶層の透過率を高める必要がある。このために、偏光板を用いる必要のない散乱モードを用いた液晶表示体が種々開発されている。散乱モードを用いる液晶表示体は、液晶層の散乱と透過によって表示を切り替えるように構成されているため、表示を明るくすることができる。
【００００５】
【発明が解決しようとする課題】ところが、表示の暗い反射型液晶表示装置においては、外光の映り込みによって、光源からの直射光が目に入ったり、背景の映り込みが顕著になることによって、表示の視認性が著しく損なわれるという問題点がある。一方、外光の映り込みを低減しようとすると、反射面の反射率や液晶層の透過率を下げざるを得ないことから、表示の明るさやコントラストが低下するという問題点がある。
【００００６】特に、散乱モードを用いる液晶表示体では、偏光板を用いないことによって表示の明るさを向上させることができるものの、液晶層が光透過状態にある場合には、逆に、反射層によって背景の映り込みが顕著になるという問題点がある。
【００００７】そこで本発明は上記問題点を解決するものであり、その課題は、反射面の反射率や液晶層の透過率を下げることなく、表示の明るさ及びコントラストを保持しつつ、高い視認性を得ることのできる反射型液晶表示装置の構造を提供することにある。
【００００８】
【課題を解決するための手段】上記課題を解決するために本発明が講じた手段は、一対の基板間に液晶層が挟持されてなり、該一対の基板の一方の基板の液晶層側に反射手段を有する反射型液晶表示装置において、前記一方の基板上には凸部が形成されてなり、該凸部上に前記反射手段が形成されてなることを特徴とする。
【００００９】この手段によれば、分散配置された複数の凸部を反映した反射面によって、反射光が平面的に変調されるため、液晶層の光透過状態におけるぎらつき感や背景の映り込みを防止することができ、表示の明るさやコントラストを低下させることなく、視認性を向上させることができる。
【００１０】また、一対の基板間に液晶層が挟持されてなり、該一対の基板の一方の基板の液晶層側の面に反射手段を有する反射型液晶表示装置において、前記反射手段の上に凸部が形成されてなることを特徴とする。

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【００１１】この手段によれば、反射面よりも表面側（すなわち液晶層側）に分散形成された凸部の存在によって、反射光が平面的に変調されるため、液晶層の光透過状態におけるきらつき感や背景の映り込みを防止することができ、視認性を向上することができる。

【００１２】ここで、前記粒状体は樹脂粒子であることが好ましい。つまり、樹脂粒子を分散配置して溶融させることによって、凸部を容易に形成することができ、製造コストの増加も抑制できる。

【００１３】請求項２においては、一対の基板間に液晶層が挟持されてなり、一方の基板の液晶層側の面に反射手段とを有する反射型液晶表示装置において、前記一方の基板上には前記反射手段が形成されてなり、前記反射手段の上に凸部が形成されてなることを特徴とする。

【００１４】特に、前記凸部が透光性を備えている場合がある。

【００１５】この手段によれば、凸部が透光性を備えているために、凸部がマイクロレンズとして作用して光の変調作用を得ることができる。

【００１６】また、前記凸部が反射性を備えている場合がある。

【００１７】この手段によれば、凸部が反射性を備えているために、反射光量を低減させることなく、光の変調作用を得ることができる。

【００１８】さらに、前記凸部が黒色である場合がある。

【００１９】この手段によれば、光の変調作用の他に、特に凸部を黒色とすることによって液晶層の光透過状態において濃い黒色を得ることができ、表示のコントラストを高めることができる。

【００２０】次に、一対の基板間に液晶層を挟持してなる反射型液晶表示装置の製造方法において、前記一対の基板の一方の基板上に複数の粒状体を分散配置し、該粒状体を加熱溶融させて複数の凸部を被着形成し、該凸部上に反射層を形成することを特徴とする。

【００２１】また、一対の基板間に液晶層を挟持してなる反射型液晶表示装置の製造方法において、前記一対の基板の一方の基板上に形成された反射面上に複数の粒状体を分散配置し、該粒状体を加熱溶融させた複数の凸部を形成することを特徴とする。

【００２２】ここで、前記粒状体は、前記粒状体が通過可能な開口部を備えたマスクを通して分散配置されることが好ましい。

【００２３】この手段によれば、マスクを通して粒状体を分散配置させることにより、例えば、導電体の粒状体を画素領域内にのみ配置させて短絡を防止したり、粒状体の配置分布を不規則にすることなどが可能となる。

【００２４】

【発明の実施の形態】次に、添付図面を参照して本発明に係る実施形態について説明する。

【００２５】（第１実施形態）図１は、本発明に係る反射型液晶表示装置の第１実施形態の液晶表示体の内部構造を拡大して示すものであり、図示の範囲は、単一の画素領域内の断面構造を示している。

【００２６】表面側のガラス基板１０の内面上にはＩＴＯ（インジウムスズ酸化物）等からなる透明電極１１が被着されており、この透明電極１１の表面上に配向膜１２が塗布形成されている。

【００２７】一方、裏面側のガラス基板２０の内面上には分散配置された多数の凸部２１が透明樹脂により形成されている。この凸部２１の形成されたガラス基板２０の内面上には、スパッタリングや蒸着等によってアルミニウムやクロム等の金属膜からなる反射電極層２２が形成されている。この反射電極層が反射手段として働く。反射電極層２２のの表面に形成された反射面は、分散された複数の凸部２１による凹凸形状を反映した形状となっている。反射電極層２２の表面上には、反射電極層２２の凹凸を埋め合わせるように、ポリイミド、ポリビニルアルコール等からなる配向膜２３が形成されて、表面がほぼ平坦な形状に成形されている。

【００２８】反射電極層２２は、図２に示す工程（ａ）～（ｃ）によってガラス基板２０の内面上に形成される。

【００２９】まず、図２（ａ）に示すように、ガラス基板２０の内面上に直径５μｍ程度の透明樹脂からなる粒状体２５を散布し、適度に分散配置させる。この粒状体２５は、樹脂製スペーサとして使用される粒状の樹脂材を用いることができる。これらの樹脂材は一般にポリプロピレン、ポリスチレン、などを原料として形成されたものである。

【００３０】粒状体の大きさは形成される凸部が液晶層の表示状態に影響を与えない範囲で適宜の径とすることができる。粒状体は透明樹脂でなくともよく、溶融させることができるものであれば、いかなる色調を呈するものでもよく、いかなる材料で構成されたものでもよい。

【００３１】次に、図２（ｂ）に示すように、ガラス基板２０の内面上の粒状体２５を加熱して溶融させ、図示のように滑らかな凸部２１を成形する。加熱温度及び時間は粒状体２５の材質や径によって異なるため、凸部２１がガラス基板２０の内面上にて大きな段差を有することなく滑らかに変形するように、予め適宜に設定する。

【００３２】最後に、図２（ｃ）に示すように、ガラス基板２０の内面上に、及び該内面上に複数形成された凸部２１の表面上に、反射電極層２２を被着する。この反射電極層２２は、例えば、Ａｌ、Ｃｒ、Ｔａ等の金属をスパッタリング、蒸着等の方法で成膜することによって形成できる。

【００３３】ここで、反射電極層２２は、ガラス基板１０の内面上に形成された透明電極１１に対向して、液晶層に電界を印加するための画素電極を構成するものであ

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る。ただし、反射電極層２２の代わりに、ガラス基板２０の内面上に反射層のみを形成し、反射層の上層に絶縁層を介して透明画素電極を形成してもよい。また、ガラス基板２０の外面上に反射層を形成し、ガラス基板２０の内面上に透明画素電極を形成してもよい。

【００３４】上記のようなガラス基板１０とガラス基板２０とを図示しないシール材を介して圧着させ、公知のスペーサ等によって基板間に所定のギャップを形成する。そして、このギャップ中に液晶層３０を注入する。液晶層３０としては、公知の種々の液晶を注入することができるが、本実施形態では、高分子分散型の複合液晶層を液晶層３０として用いている。この複合液晶層は、例えば、光硬化型の高分子モノマーと所定の液晶とを混合、相溶させた溶液を基板間に注入した後、基板を通して光を照射して高分子モノマーを光重合させ、重合された高分子粒子を液晶中に分散させることによって形成することができる。このように形成された高分子粒子及び液晶分子は、通常は、電界無印加時において配向膜のラビング処理の方向に共に配向された状態となる。

【００３５】上記高分子分散型の複合液晶層においては、液晶分子が誘電異方性と屈折率異方性とを備えていることから、高分子粒子の屈折率と液晶分子の屈折率とが電界印加の有無によって、ほぼ等しくなったり、異なった値になったりすることを利用して表示状態が変化するように構成されている。例えば、電界無印加時において、配向の揃った高分子粒子と液晶分子とが、基板面と垂直な方向に入出する光に対してほぼ同様の屈折率を呈するように設定し、電界印加時において、液晶分子が電界方向に姿勢を変えた場合には、高分子粒子と液晶分子とが異なる屈折率を呈するように設定すると、電界無印加時には液晶層は光透過状態となり、電界印加時には液晶層は光散乱状態となる。

【００３６】本実施形態では、上述のような反射電極層２２を形成することによって、その表面の反射面に微少な凹凸が形成されるため、液晶層３０の光透過状態における反射面のぎらつき感や、背景の映り込みを低減することができるので、外光の映り込みによる視認性の低下が抑制される。

【００３７】また、図２に示すように、粒状体（具体的な形状としては、短い棒状のものも含む。ただし、短い棒状のものに限定されるものではない）を分散配置した後に、粒状体を溶融させて凸部を形成し、この表面上に反射層を形成するようにしたので、微細な凹凸形状を比較的容易かつ低コストで形成することができる。

【００３８】（第２実施形態）図３は、本発明に係る第２実施形態の反射電極層近傍の構造を示す拡大断面図である。この実施形態においては、ガラス基板２０の内面上には、上記第１実施形態の反射電極層２２の代わりに、反射電極層２２と同様の材質及び製法で形成された反射電極層２５がほぼ平坦に設けられている。この反射電極層２５の表面上には、図２に示した方法と同様の方法で、粒状体を溶融して形成されたほぼ透明の複数の凸部２７が分散して設けられている。

【００３９】この実施形態では、図３に示した反射電極層近傍の構造以外の構造については図１に示す第１実施形態の構造と等しいため、その説明は省略する。

【００４０】この第２実施形態では、反射電極層２６の表面上に分散配置された複数の凸部２７が形成され、個々の凸部２７がマイクロレンズとして機能するため、液晶表示体の内部にマイクロレンズアレイが構成されることとなり、凸部２７の屈折率によって反射光が平面的に変調されることから、液晶層３０の光透過状態における表示のぎらつき感や背景の映り込みを低減することができる。

【００４１】ここで、反射層２６上に形成される凸部２７は、上述のように透明であっても効果が得られるが、例えば、反射性の材料を用いることによって凸部２７の表面にも反射面を形成すると、上記第１実施形態と ほぼ同様の凹凸状の反射面を構成することができる。

【００４２】また、凸部２７を透明ではなく、所定の色調を呈する材料で形成することによって、反射面上に分散配置された有色部が分散されている状態を作り出すことができる。この場合にも、反射光を平面的に変調させることができるので、本実施形態と同様の効果をより効果的に得ることができる。この場合には特に、凸部２７の色調を黒色とすることによって、液晶層３０の光透過状態における黒色を濃く表示することができ、表示のコントラストを高めることができる。

【００４３】図４乃至図７は、液晶表示体に構成された画素領域に対する粒状体若しくは凸部の平面的な配置を示すものである。図４は、上記第１実施形態に対応する反射電極層２２の形成領域と、凸部２１の形成位置との関係を示すための平面図である。凸部２１は、粒状体を反射電極層２２の形成予定領域とは無関係に分散させて配置した分散状態でそのまま形成されている。

【００４４】一方、図５は、第２実施形態に対応する反射電極層２５と形成領域と、凸部２７の形成位置との関係を示すための平面図である。この場合、先に反射電極層２６が形成されているために、粒状体は反射電極層２６の表面上のみに散布され、その結果、凸部２７も反射電極層２６の表面上のみに形成されている。ここで、粒状体の散布は、反射電極層２６に合致する形状の開口部を備えたマスクを介して行われる。この場合、粒状体が仮に金属等の導電体であっても、反射電極層２６間の短絡を防止することができる。

【００４５】図６は、第１実施形態と同様構造の液晶表示体を形成するに際して、マスクを介して粒状体を散布した場合の状態を示す平面図である。この場合には、図示点線で示す複数の開口部ｏが反射電極層２２の形成予定領域に対してほぼランダムに配置されるように形成した

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マスクAを介して、基板上に柱状体を散布し、分散配置する。このようにすることによって、各反射電極層22の形成された画素領域に対して凸部21が不規則に配置されることとなり、見かけ上の表示画素の変形やカラー表示の色ずれ等を防止することができる。

【0046】なお、上記第1及び第2実施形態において、凸部と反射層とは直接接触していなくてもよく、間に別の層などを介して形成されていてもよい。特に、第2実施形態においては、凸部をレンズ状に形成することによって、光を平面的に変調させることができるため、反射面よりも表面側でさえあれば、任意の位置（例えば、ガラス基板10の内面など）に形成しても、同様の効果を得ることができる。

【0047】

【発明の効果】以上説明したように本発明によれば以下の効果を奏する。

【0048】すなわち、分散配置された複数の凸部を反映した反射面によって、反射光が平面的に変調されるため、液晶層の光透過状態におけるぎらつき感や背景の映り込みを防止することができ、表示の明るさやコントラストを低下させることなく、視認性を向上させることができる。

【0049】また、反射面よりも表面側に分散形成された凸部の存在によって、反射光が平面的に変調されるため、液晶層の光透過状態におけるぎらつき感や背景の映り込みを防止することができ、視認性を向上することができる。

【図面の簡単な説明】

【図1】本発明に係る第1実施形態の液晶表示体の構造を示す拡大断面図である。

【図2】第1実施形態における凸部及び反射電極層の形成工程を示す工程断面図である。

【図3】本発明に係る第2実施形態の液晶表示体における反射電極層の近傍の構造を示す断面図である。

【図4】第1実施形態における凸部の分散配置状態を示す平面図である。

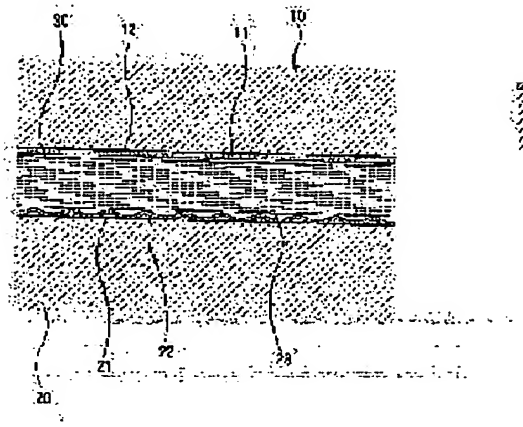
【図5】第2実施形態における凸部の分散配置状態を示す平面図である。

【図6】第1実施形態における凸部の異なる分散配置状態を示す平面図である。

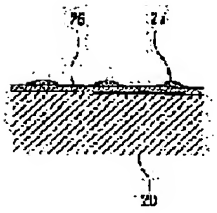
【符号の説明】

10，20　基板
11　透明電極
12，23　配向膜
21，27　凸部
22，26　反射電極層

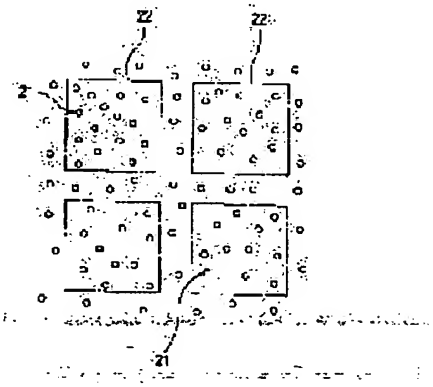
【図1】



【図3】



【図4】



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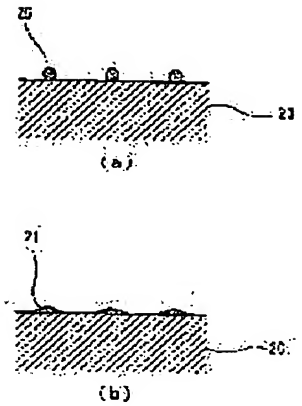
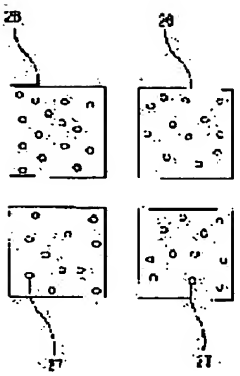
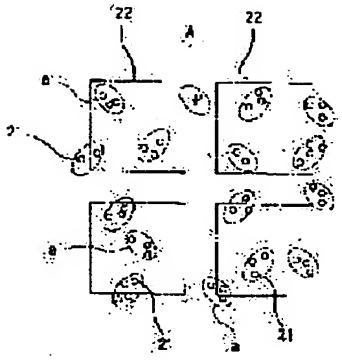
【図2】



【図5】



【図6】



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